Ontario Department of Agriculture

Fifty-Fifth Annual Report

OF THE

ENTOMOLOGICAL SOCIETY

OF

ONTARIO

1924

PRINTED BY ORDER OF
HON. J. S. MARTIN, Minister of Agriculture

TORONTO
Printed by CLARKSON W. JAMES, Printer to the King's Most Excellent Majesty
1925

PRODUCED BY
The
United Press
LIMITED
TORONTO
CANADA

CONTENTS

PAGE

OFFICERS FOR 1924-1925 4

FINANCIAL STATEMENT 4

ANNUAL MEETING 5

Report of the Council 5

Report of the Montreal Branch 6

Report of the Toronto Branch 7

Report of the British Columbia Branch 7

Report on Insects of the year, Division No. 1: C. B. HUTCHINGS 8

Division No. 3: A. COSENS 9

Division No. 5: J. D. DETWILER 10

Division No. 6: H. F. HUDSON 11

Lessons from the Grasshopper Outbreak of 1919-23 in Manitoba: NORMAN CRIDDLE 13

The Rose Chafer and Farm Management: WILLIAM A. ROSS and J. A. HALL 16

The Lilac Leaf Miner (*Gracilaria syringella* Fabr.): C. B. HUTCHINGS 19

Notes on the Occurrence of the Lesser Grapevine Flea-Beetle in Canada: ARTHUR GIBSON 23

Notes on Insect Parasites of *Phyllophaga anxia* in the Province of Quebec: C. E. PETCH and G. H. HAMMOND 24

Note on *Ptinus fur* L. and *villiger* Reit. as Stored Product Pests in Canada: C. HOWARD CURRAN 28

Warfare against the Insects: C. L. METCALF 30

The Spread and Degree of Infestation of the European Corn-Borer in 1924: W. N. KEENAN 47

Mortality of the Larvae of the European Corn-Borer (*Pyrausta nubilalis* Hubn.) in the Early Instars in 1924: PROF. L. CAESAR 50

A Field Study of the Reduction of European Corn-Borer Larvae in Standing Corn: R. H. PAINTER and G. A. FICHT 53

The Introduction and Colonization in Ontario of Two Hymenopterous Parasites of the European Corn Borer: A. B. BAIRD 54

A Brief Note on Farm Cutting Boxes and Corn Shredders as Factors in the Control of the European Corn Borer (*Pyrausta nubilalis* Hubn.): G. A. FICHT and R. H. PAINTER 56

Discussion on Corn Borer 57

The Outbreak of the Gipsy Moth in Quebec: LEONARD S. MCLAINE 60

A Study of the Methods Used in Growing Entomophthorous Fungi in Cases Prior to their Artificial Dissemination in the Orchards: ALAN G. DUSTAN 63

Notes from a Study of *Nepticula pomivorella* Packard: HAROLD FOX 67

Notes on the Life History of the Lesser Clover Weevil (*Phytonomus nigrirostis*): H. F. HUDSON and A. A. WOOD 71

Entomology in the Rural Schools in the Province of Quebec: PROF. GEORGES MAHEUX 73

Observations of the Host-Selection Habits of *Pieris rapae* L.: C. R. TWINN 75

Miscellaneous Notes on the Pear Psylla Problem: WILLIAM A. ROSS 80

Insects of the Season: W. A. ROSS and L. CAESAR 84

The Entomological Record, 1924: NORMAN CRIDDLE 89

INDEX 107

Entomological Society of Ontario

OFFICERS FOR 1924-1925

President—DR. J. M. SWAINE, Entomological Branch, Ottawa.

Vice-President—REV. FATHER LEOPOLD, La Trappe, Que.

Secretary-Treasurer—PROF. A. W. BAKER, B.S.A., O. A. College, Guelph.

Curator and Librarian—J. A. FLOCK, O. A. College, Guelph.

Directors—Division No. 1, C. B. HUTCHINGS, Entomological Branch, Dept. of Agriculture, Ottawa; Division No. 2, C. E. GRANT, Orillia; Division No. 3, DR. A. COSENS, Toronto; Division No. 4, F. J. A. MORRIS, Peterborough; Division No. 5, DR. J. D. DETWILER, Western University, London; Division No. 6, J. F. HUDSON, Strathroy; Division No. 7, W. A. ROSS, Vineland Station.

Directors (ex-Presidents of the Society)—REV. PROF. C. J. S. BETHUNE, Toronto; PROF. JOHN DEARNESS, London; PROF. WM. LOCHHEAD, Macdonald College, Que.; JOHN D. EVANS, Trenton; PROF. E. M. WALKER, University of Toronto; ALBERT F. WINN, Westmount, Que.; PROF. LAWSON CAESAR, O. A. College, Guelph; ARTHUR GIBSON, Dominion Entomologist, Ottawa.

Editor of "The Canadian Entomologist"—DR. J. MCDUNNOUGH, Entomological Branch, Ottawa.

Delegate to the Royal Society of Canada—THE PRESIDENT.

FINANCIAL STATEMENT

FOR THE YEAR ENDING OCTOBER 31ST, 1924

Receipts		*Expenditures*	
Cash on hand, 1923	$484 92	Printing	$1,433 22
Subscriptions	587 80	Salaries, 1923 and 1924	400 00
Membership dues	140 30	Expense	90 31
Advertisements	146 00	Insurance	36 00
Back numbers	46 21	Exchange	3 70
Cuts	3 75	Balance cash on hand	458 83
Bank interest	9 23		
Exchange	3 85		
Government grant	1,000 00		
	$2,422 06		$2,422 06
By cash on hand	$458 83		
To printing account payable	115 00		
Net balance	$343 83		

Auditors—J. A. FLOCK
L. CAESAR.

Respectfully submitted,

A. W. BAKER,
Secretary-Treasurer.

Entomological Society of Ontario

ANNUAL MEETING

The sixty-first annual meeting of the Entomological Society of Ontario was held at the Ontario Agricultural College, Guelph, Thursday and Friday, November 27th and 28th, 1924.

The morning and afternoon meetings were held in the lecture room of the Department of Entomology. The Thursday evening meeting was held in Memorial Hall, when President Reynolds welcomed the members and visitors to the college and Dr. C. L. Metcalf delivered the public lecture on "Methods of Warfare Against Insects."

REPORT OF THE COUNCIL

The Council of the Entomological Society of Ontario begs to present its report for the year 1923-24.

The Diamond Jubilee Meeting of the Society was held in the quarters of the Dominion Entomological Branch at Ottawa on Thursday, Friday and Saturday, November 1st, 2nd and 3rd.

The meeting was well attended by members of the Society from various provinces of the Dominion, by a number of American entomologists and numerous other visitors. Much credit must be given to the local committee for the success of the meeting.

The Thursday evening meeting was held in the Assembly Hall of the Normal School, when Dr. A .F. Burgess delivered the public address on "The Value of Natural Enemies of Injurious Insects." On Friday evening a dinner was held at the University Club. After dinner the members and visitors were addressed by Mr. J. A. Ruddick of the Dominion Department of Agriculture. Mr. Morris then delivered the presidential address:—"Nature's Clairvoyant, A Study of W. H. Hudson." Mr. Gibson then read an interesting paper from Dr. Bethune, "The Early Days of the Entomological Society of Ontario."

During the meeting the following papers were presented:

1. Notes on the Rose Curculio in Manitoba (10 minutes), Mr. H. A. Robertson, Entomological Branch, Treesbank, Man.
2. The Control of the Apple Sucker (*Psylla mali* Schmid.) in Nova Scotia by *Entomophthera sphaerosperma* Fres. (15 minutes), Mr. A. G. Dustan, Entomological Branch, Wolfville, N.S.
3. Concerning the Canadian Species of the Syrphid Genus *Eumerus* (Diptera) (5 minutes), Mr. C. Howard Curran, Entomological Branch, Ottawa.
4. The Occurrence of the Ptinid Beetle, *Niptus hololeucus*, in North America (5 minutes), Mr. Arthur Gibson, Entomological Branch, Ottawa.
5. Transfer tests with the Green Apple Aphid (*Aphis pomi* DeGeer; *Aphis spiraecola* Patch) (10 minutes), Edith M. Patch, Entomologist, Orono, Maine (Read by Mr. W. A. Ross).
6. The Distribution of Canadian Odonata (15 minutes), Dr. E. M. Walker, University of Toronto, Toronto, Ont.
7. Two Problems in Natural Control (15 minutes), Mr. Norman Criddle, Entomological Branch, Treesbank, Man.
8. The Present Status and Distribution of the Apple and Thorn Skeletonizer (*Hemerophila pariana*) (10 minutes), Dr. M. D. Leonard, Associate State Entomologist, Albany, N.Y.

9. The Inhalation of Arsenical Insecticides (15 minutes), MR. ARTHUR KELSALL, Entomological Branch, Annapolis, N.S.
10. Taxonomic and Synonymic Tendencies, with Special Reference to the Diptera (15 minutes, MR. C. HOWARD CURRAN, Entomological Branch, Ottawa.
11. The Control of the Grape Leaf-hopper (10 minutes), MR. W. A. ROSS, Entomological Branch, Vineland, Ontario.
12. The New Regulations under the Destructive Insect and Pest Act (15 minutes), MR. L. S. McLAINE, Entomological Branch, Ottawa.
13. Studies in the Life-history, Bionomics and Control of the Cabbage Worm in Ontario (10 minutes), MR. C. R. TWINN, Entomological Branch, Ottawa.
14. The Onion Maggot and Its Control (10 minutes), MESSRS. H. E. GRAY, G. H. HAMMOND, and T. ARMSTRONG, Entomological Branch, Lethbridge, Ottawa and Montreal.
15. The Garden Springtail (*Sminthurus hortensis*) as a Crop Pest (15 minutes), DR. W. H. BRITTAIN, Provincial Entomologist, Truro, N.S.
16. Notes on the Life-history of *Hypera punctata*, MESSRS. H. F. HUDSON and A. A. WOOD, Entomological Branch, Strathroy. Ont.
17. Winds and Gipsy Moth Spread (15 minutes), DR. H. L. McINTYRE, Supervisor, Gipsy Moth Control, Albany, N.Y.
19. Canadian Problems in Forest Entomology (15 minutes), DR. J. M. SWAINE, Entomological Branch, Ottawa.
20. Rhagoletis pomonella Walsh, and Two Allied Species (Diptera) (5 minutes), MR. C. HOWARD CURRAN, Entomological Branch, Ottawa.
21. Insects of the Season in Ontario (5 minutes), PROF. L. CAESAR, Guelph, and MR. W. A. ROSS, Vineland Station, Ont.
    Read by title only at request of PROF. CAESAR.
22. Insects of the Season in Quebec (5 minutes), MR. G. MAHEUX, Provincial Entomologist, Quebec, Que.
23. Notes on Lice, with Special Reference to the Chicken Louse (15 minutes), DR. A. B. WICKWARE, Health of Animals Branch, Ottawa.
24. Flower Relations of Wild Bees (15 minutes, Lantern), MR. H. L. VIERECK, Entomological Branch, Ottawa.
25. The Spread of the European Corn Borer in Ontario in 1923 (15 minutes), MR. W. N. KEENAN, Entomological Branch, Ottawa.
26. The Status of the Control Practice for the European Corn Borer in Ontario (15 minutes), MR. H. G. CRAWFORD, Entomological Branch, Ottawa.
27. The Present Status and Spread of the Japanese Beetle, DR. C. H. HADLEY, Harrisburg, Penn.
28. The Control of the European Corn Borer in the Light of our Present Knowledge (15 minutes), PROF. L. CAESAR, Ontario Agricultural College, Guelph.
29. A Study of the Pupal Case of *Prionoxystus macmurtrei* (10 minutes), MR. C. B. HUTCHINGS, Entomological Branch, Ottawa.
30. Methods in Insect Photography (15 minutes), PROF. A. BROOKER KLUGH, Queen's University, Kingston, Ont.
31. Notes on the Injury Caused by *Monochamus scutellatus* to Burned Standing Timber in New Brunswick (15 minutes), DR. J. D. TOTHILL, Entomological Branch, Fredericton, N.B.

It is the sad duty of the Council to record the death of our esteemed colleague, Mr. R. C. Treherne, the Vice-president of our Society. Each member of the Council knows that the country has lost a strong man in entomology, and each feels that he has lost a true friend.

REPORT OF THE MONTREAL BRANCH

The fifty-first annual meeting was held on May 10th, 1924, in the Lyman Entomological Room, Redpath Museum, McGill University.

Seven meetings were held during the season with an average attendance of six members.

The following papers were read during the year:

Notes on Tenthredinidae .... J. W. BUCKLE.
A Midget Bug .... GEO. A. MOORE.
Notes on Ranatra fusca, and how the female protects herself from parasitical mites .... T. C. BARNES.
Stilt bugs (Neididae) .... GEO. A. MOORE.
Life History of Prociphilus tessallata .... T. C. BARNES.

Reduviidae or Assassin Bugs .... Geo. A. Moore.
Reduvius personata .... Geo. A. Moore.
Histology of the Alimentary Canal of Blatta orientalis .... T. C. Barnes.
Hibernation of aquatic insects .... T. C. Barnes.
British Glowworm .... G. H. Hall.
Lygaeus kalmii .... Geo. A. Moore.

The Treasurer reported a balance on hand of $180.11.

The following were elected officers: President, Geo. A. Moore; Vice-President, G. H. Hall; Secretary-Treasurer, J. W. Buckle; Council, G. Chagnon, A. C. Shepherd and J. Warren.

J. W. Buckle, *Secretary.*

REPORT OF THE TORONTO BRANCH

During the past year seven regular meetings of the branch were held and the average attendance was nine persons. One new member was elected, Miss F. Hahn.

At the meetings of the Branch the following seven papers and addresses were given:

The Order Hymenoptera .... Dr. E. M. Walker.
Sawflies and Horntails .... Messrs. S. Logier and N. K. Bigelow.
Chalcid-flies and Ichneumon-flies .... Dr. N. H. C. Ford and Dr. W. A. Clemens.
Solitary and Social Wasps .... Dr. E. M. Walker and H. H. MacKay.
Solitary Bees .... Mr. N. K. Bigelow.
Social Bees .... Mr. A. T. Logier.
The Food Habits of Ants .... Mr. S. Logier.

The treasurer reported a balance on hand of $17.25.

Shelley Logier, *President.* H. H. MacKay, *Secretary.*

REPORT OF THE BRITISH COLUMBIA BRANCH

The twenty-third annual meeting of the British Columbia Branch was held in the Provincial Museum, Victoria, on Saturday, March 15th, 1924; the attendance was small owing to sickness, etc.

The following papers were read:

Leaf Rollers attacking orchards in the Okanagan .... E. P. Venables.
Vespa, the first paper-maker .... W. B. Anderson.
Notes on collecting .... A. W. Hanham.
The evolution of the young entomologist .... R. S. Sherman.
New Records in Hemiptera .... W. Downes.
Insects of the year on Vancouver Island .... W. Downes.
Life history notes on the aphids of the genus Pemphigus .... R. Glendenning.

The election of officers resulted as follows: Hon. President, F. Kermode; President, L. E. Marmont; Vice-President (coast), R. S. Sherman; Vice-President (interior), E. P. Venables. Advisory Board: Messrs. Bannister, Downes, Lyne, Ruhmann and Whittaker. Honorary Secretary-Treasurer, R. Glendenning, Agassiz, B.C.

The treasurer reported a balance on hand of $133.75.

R. Glendenning, *Hon. Secretary-Treasurer.*

REPORT ON INSECTS OF THE YEAR

Division No. 1, Ottawa District.—C. B. Hutchings
Shade Tree Insects

The Maple Leaf Cutter, *Paraclemensia acerifoliella* Fitch has been exceedingly abundant this summer throughout the Provinces of Quebec and Ontario. Trees in the vicinity of Ottawa have suffered considerably from this small leaf-feeding insect, though not to the severe extent as those in certain areas in Eastern Ontario. The worst damage done, however, was in the Eastern Townships, where some of the large sugar bushes were completely stripped of their foliage. The beech also suffered considerably from this insect.

The Fall Webworm, *Hyphantria textor* Harris, was again quite apparent this autumn, but perhaps in less numbers than in 1923. It was seen chiefly on ash, apple and elm, although other hosts claimed its attention.

The Willow Borer, *Cryptorhynchus lapathi* Linn, was found in large numbers at Aylmer and the surrounding district on willow and poplar. The damage to willows especially was quite severe.

The Spring Canker Worm, *Paleacrita vernata* Pack, appeared again in Ottawa south and completely stripped large numbers of apple, elm, basswood and other trees. It was nevertheless not so numerous this year as in 1923 or 1922.

Several species of sawflies, *Tenthredinidae*, were numerous on oak, butternut, hickory, elm and willow.

Cicadas were prevalent about Aylmer during summer. They made their appearance very early in the season this year, some being taken during the later part of June and early in July.

The Forest Tent Caterpillar, *Malacosoma disstria* Hubn., appeared in less numbers this year and only a few scattered webs were observed.

The Birch Leaf Skeletonizer, *Buccalatrix canadensisella* Chamb., has been remarkably scarce this year. During previous seasons 1923, 1922 and 1921, especially the last two mentioned, it was very abundant and ruined the foliage of all birches in Ontario as far west at Fort William.

The White Spotted Sawyer, *Monochamus scutellatus* Say, was fairly active this summer on white pines. Many beetles were seen and taken on the wing.

The Walking Stick Insect, *Diapheromera femorata* Say, has been reported from different parts of Ottawa as being uncommonly numerous. It was found feeding chiefly on basswood, oak and hazel.

The Lilac Leaf Miner, *Gracilaria syringella* Fab., was exceedingly severe this summer, everywhere the lilac was to be found. In the central part of the city these shrubs appeared to be special objects of attack. The infestation has spread westward since last year and is now to be found at the Central Experimental Farm. Some species, however, appeared to be quite immune, and in spite of heavy infestation all around remained free of any signs of attack.

Field Crop Insects

The Frit Fly, *Oscinis variabilis* Lw., during June and July caused considerable injury to wheat and barley plots at the Central Experimental Farm, Ottawa. Adult flies were emerging on July 9th.

Grasshoppers, *Orthoptera*, have been numerous in certain localities on sod and meadow lands. *Melanoplus atlantis* Riley; *M. femur rubrum* de Geer; *M. bivittatus* Say, were the species observed.

Fruit and Garden Insects

The Codling Moth, *Carpocapsa pomonella* Linn., was again abundant in unsprayed orchards.

The Raspberry Cane-borer, *Oberea bimaculata* Oliv., has been very general and severe in its attacks on the young cane tops this summer. As this fruit is being more and more extensively grown each year in the outlying districts of Ottawa, the borer becomes of considerable economic importance.

The Carrot Rust Fly, *Psila rosea* Fab., was particularly severe this summer and caused serious damage to the carrot plots at the Central Experimental Farm, Ottawa.

The Cabbage Butterfly, *Pieris rapae* Linn., although numerous about Ottawa this year, was less injurious than in 1923.

The Tarnished Plant Bug, *Lygus pratensis* Linn. Flowers and truck gardens suffered from a heavy widespread infestation of this insect, especially towards the close of the season. Asters and dahlias, particularly, were affected. The injury begins in the bud, and the flowers develop imperfectly, or not at all. In some localities these crops were a failure on account of the ravages of this pest.

The Cabbage Maggot, *Hylemyia brassicae* Bouche. The injuries by this insect were very noticeable in the Ottawa district on cabbage, turnip and radish; as a consequence many home and truck gardens suffered considerable loss.

Miscellaneous

The Cigarette Beetle, *Lasioderma sericorne* Fab. Both larvae and beetles were found at Ottawa in tins of tobacco which originally had come from Montreal. The tobacco was so badly injured that it was utterly useless.

Division No. 3, Toronto District.—A. Cosens

My report this year will be limited to a few observations made while enjoying a vacation in the Province of Quebec.

In that district three species of forest insects are outstanding in destructiveness: The white pine weevil, *Pissodes strobi* Peck; the spruce bud-worm, *Tortrix fumiferana* Clemens; and the larch sawfly, *Lygaeonematus erichsonii* Hartgn. The larvae of the first bore in the inner bark of their host, while those of the other two feed upon the foliage of the infested trees.

The white pine weevil was noted as affecting the introduced Norway spruce as well as the white pine A number of drooping leaders of the former were examined and invariably disclosed numerous larvae tunnelling in them. Many of the trees bore deformed tops, where leaders had been killed by attacks of the insects in former years. As far as observed the native white spruce is immune from attack.

The spruce bud-worm has been known for many years in Quebec. In 1909 it was reported as very plentiful and causing much damage to the spruces and balsams in the Upper Gatineau country. It has been reported also as firmly established in the Beaupre district and along the Mattawin. This year it was stated to be not as plentiful as usual. Probably owing to insect parasites the pest is not always at its peak of destructiveness. Were this not the case the spruces and balsams would be doomed in districts where the infestation is of long standing.

In various localities, especially north of Three Rivers, the larch sawfly did a great deal of damage during the past season. Many fine stands of young tamarack were almost defoliated by the pest.

The problem of the protection of the trees from these three pests is a difficult one to solve. Spraying on such a large scale is out of the question. All that seems feasible is to cut the timber as soon as the trees are seriously endangered by the attacks of the insects. Even this plan is not always possible as the stands infested are in many instances too immature to be profitably marketed. This was true this year in the case of the tamaracks attacked by the larch sawfly. Over large areas the trees were thrifty but small, not averaging more than five inches at stump height.

In this report, I wish also to record the collection of a species of the False Scorpion or Chelifer, that is known to attach itself to house-flies. The afflicted fly was caught in the nursery office of the Laurentide Pulp and Paper Co., Proulx, Quebec. There were three specimens of the pest attached to the legs of the fly and one has still retained its hold after being preserved in formalin.

These Chelifers are strange little creatures. Their yellowish, flattened bodies not more than one-tenth of an inch in length, are very inconspicuous. Their close relation to both the spiders and the scorpions is clearly shown in the united head and thorax, the four pairs of legs and the well-developed pincer-like mouth appendages.

Whether the pseudo-scorpion is to be regarded as a fly parasite or not is uncertain. It is equally difficult to decide whether it should be considered as leading a predatory life and pulling down the flies by its numbers. The only point that appears positively certain is that the fly furnishes the Chelifer with an excellent means of aerial transportation.

Division No. 5.—J. D. Detwiler

During the latter part of the summer arctiid caterpillars were very much in evidence. *Isia isabella* was, I think, more abundant than I have ever seen it. The harlequin milkweed caterpillar, *Euchaetias egle*, was very common on the milkweed, *Asclepias syriaca*. The fall webworms, *Hyphantria*, were fairly common. Early in the summer, onions in my garden were attacked by small caterpillars which on rearing also proved to be woolly bears (probably *Diacrisia virginica*) but the adults have not yet emerged. Late in the summer I also notice some large sycamore trees, *Platanus occidentalis*, practically stripped of their foliage by what I believe was *Halisidota harrisii*. *H. tesselaris* and *H. maculata* were also common.

The datanas were quite plentiful. The black walnut trees on the university campus were badly infested The caterpillars were no doubt those of *Datana integerrima; Datana ministra* was common.

The apple trees on our campus were badly infested by the codlin-moth, *Carpocapsa pomonella*, and the apple maggot, *Rhagoletis pomonella*. The leaf miner, *Nepticula pomivorella*, was also rather abundant.

In the garden the imported cabbage worm, *Pieris rapae*, and the striped cucumber beetle, *Diabrotica vittata*, were present in considerable numbers as usual. My sweet corn, Golden Bantam, was badly infested with the European corn borer, *Pyrausta nubilalis*.

I might also report that I found the egg parasite, *Tetrasticus asparagi*, of the common asparagus beetle, *Crioceris asparagi*, quite abundant here in 1922. Mr. Gahan, of the United States National Museum, kindly identified it and Mr. Rohwer stated that it had not been previously reported from this locality.

In the clover the larvae of *Hypera punctata* were reported numerous near London during the early part of June, but about June 15th the number rapidly

decreased. Of course their partial disappearance was to be expected. From the same locality great numbers of clover seed midges were reported, also that the yield of clover seed was very low. Aphids on the clover were said to be very numerous.

A preliminary study of the galls of the vicinity was carried on by a student, Miss Nelda Wright, and the following forms are reported.

Box Elder:
Warty swellings on leaves—*Eriophyes negundi.*
Box elder leaf gall—*Contarinia negundifolia.*

Cherry:
Wild cherry pouch gall—*Eriophyes padi.*

Goldenrod:
Goldenrod ball gall—*Eurosta solidaginis.*
Goldenrod rosette gall—*Rhopalomyia capitata.*
Elliptical goldenrod gall.—*Gnorimoschema gallaesolidaginis.*

Hackberry:
Hackberry nipple gall—*Pachypsylla celtidis-mammae.*
Hackberry blister gall—*Pachypsylla vesiculum.*

Linden:
Linden twig gall—*Cecidomyia citrina.*
Linden wart gall—*Cecidomyia verrucicola.*
Linden mite gall—*Eriophyes abnormis.*

Oak:
Saucer-like gall—*Dryophanta discus.*
Woolly-gall—*Andricus flocci.*
Jewel oak gall—*Philonix marrocarpae.*
Conical twig gall—*Andricus ventricosus.*
Oak bullet gall—*Disholcaspis globulus.*

Poplar:
Poplar vagabond gall—*Pemphigus vagabundus.*
Basal leaf gall—*Pemphigus populicaulis.*

Rose:
Mossy rose gall—*Rhodites rosae.*

Willow:
Willow cone gall—*Rhabdophaga strobiloides.*
Willow twig gall—*Sackenomyia packardi.*

Division No. 6.—H. F. Hudson

The season has been cool, wet, and generally backward, which doubtless has helped to retard the activities of certain insects, while on the other hand it has been decidedly helpful to others, notably the European corn-borer. In the latter case, at the time when eggs were hatching, the weather being cool, a much larger percentage of young larvae were able to enter the stalk than would otherwise have been the case had the weather been hot, for undoubtedly the direct rays of a hot sun have a detrimental effect in reducing the number of borers which gain access to the plant. The activities of cut-worms were likewise carried over a longer period than usual, their work being continued almost to the end of June. The more important insect pests noted are as follows:—

Field Crop Insects

Wireworms. The species involved is not known, they were reported to be generally destructive in Lambton, Essex, and Elgin Counties.

Cutworms. There are probably several species involved, material not having been received. They were reported as being extremely abundant and injurious to corn, cauliflower, potatoes, and tobacco. The outbreak appears to have fairly general, and was recorded from Middlesex, Elgin, Kent and Essex Counties.

European Corn-borer (*Pyrausta nubilalis*). Possibly the most destructive pest of the year, certainly as far as corn is concerned. The intensity of attack has been most marked. It was decidedly injurious to the corn crop throughout Western Ontario. Early sweet corn was particularly hard hit in Middlesex County.

Hessian Fly. We have seldom had a year in which we have been so remarkably free from this insect. A few early sown fields were attacked last fall, but this spring, owing to weather conditions at the time the spring brood emerged, no injury was occasioned.

Wheat Midge. Although the little pink red maggots could be secured in the wheat heads in almost any field, it was noted they were more abundant in low, damp locations. No injury resulted from their presence, outside a few shrunken grains in the affected heads.

Potato Beetles. On the whole the insect was less numerous than last year. A number of late planted fields were not sprayed at all.

Potato Flea Beetle. A very marked reduction over last year.

Potato Leaf Hopper. Quite common, and fairly injurious around London, in unsprayed fields.

Seed Corn Maggot. Reported as being slightly injurious in Kent County.

Bean Maggot. A slight but fairly general injury noted in Elgin County.

Pea Weevil. Noted in exhibition peas at Simcoe Fair.

Garden Insects

Cucumber Beetles. These were quite abundant this year, being especially prevalent from June 16th—20th. Spraying with nicotine dust when the beetles are pairing seems a very effective control.

Cabbage Maggot. Decidedly injurious where the corrosive sublimate treatment had not been applied.

Radish Maggot. On light land there appeared to be no injury, but on heavy land the crop was useless.

Cabbage White. Quite abundant this year, but a large percentage of the larvae were either parasitized or killed by the bacterial fungus "flacherie."

Carrot Worm. Not as abundant as last year, the larvae being heavily parasitized.

Tomato Worm. Unusually scarce this year.

Parsnip Webworm. Very abundant this year, particularly in pasture fields where cow parsnip, *Heracleum lanatum*, abounds.

Tarnished Plant Bug. Generally reported abundant in celery and flower gardens.

Four Lined Leaf Bug. Unusually abundant and destructive this year in perennial and herbaceous borders.

Lixus Concavus. Present in almost all rhubarb plantations.

Papaipema cataphracta. Injurious to potatoes and delphiniums.

Fruit Insects

Codling Moth. In unsprayed orchards this pest was quite common.

San Jose Scale. Generally on the increase in Western Ontario.

Aphids (species unknown). Very common on apple trees, deforming the fruit.

Alypia octomaculata. The larvae of this moth were unusually abundant this year in grapes.

Plum Curculio. Several local cherry plantations were injured by this insect, rendering the fruit useless.

Black Cherry Aphis. Very common this year.

Rose Chafer. We experienced the largest outbreak of this pest we have ever had. It feeds on practically every green thing, including immature fruit.

Live Stock Insects

Heel Fly. This pest is causing great concern with cattle men, cattle were reported to have died from gadding near the Muncey reserve.

Miscellaneous Insects

The leaf-eating beetle *Serica serica* was quite common on hazel and hawthorn.

Dichelonycha subvittata was common on linden and maple.

Ithycerus novaboracensis was taken quite frequently from beech.

LESSONS FROM THE GRASSHOPPER OUTBREAK OF 1919–23 IN MANITOBA

Norman Criddle, Treesbank, Manitoba

The grasshopper outbreak of 1919-23 was the first extensive one experienced in Canada since 1874. It was also the most important one we have ever had owing to the fact that during the earlier infestation settlers were few and far between, whereas now vast stretches of growing grain are involved. The money at stake was, therefore, immeasurably greater.

We know very little about the former outbreak excepting that eye-witnesses proclaimed it to have been a sudden visitation of winged locusts in which the insects dropped from a clear sky, resembling as they came down the flakes of a snowstorm. Arriving in late summer they remained to breed, and it was from the young hoppers of the following year that most of the damage resulted. This invasion consisted of the long-winged Rocky Mountain locust, *Melanoplus spretus* Uhl., which had come from more arid parts, probably from the foothills of the Rockies, but whether there were other species involved we do not know.

The 1919–23 outbreak was less spectacular and it had its inception in quite a small area of southwest Manitoba and southeast Saskatchewan. The species involved, too, (*Camnula pellucida* Scudd.), was one that entomologists had previously experienced little trouble with, and as there had been no warnings of grasshopper activities the previous year, we were caught somewhat unprepared.

Most of our previous experience in grasshopper fighting had been derived from a rather restricted infestation in 1900–04, during which we had discarded the cumbersome hopperdozer in favour of poisoned baits and in other respects had made some progress. Kansas and other states had experienced grasshopper troubles between the 1900 and 1919 outbreaks and we were, therefore, able to profit from their discoveries. Our work in Quebec, too, had given us some additional data, all of which we took full advantage of.

From the small beginnings of 1919 the grasshoppers quickly multiplied and spread over most of the southwestern portion of Manitoba and extended well to the northward. But the greatest extension was west, and ultimately a very large area in Saskatchewan became involved, as well as practically all of southern Alberta.

It is not my intention to go into details either as to the area infested or the amount of poisoned bait used. Sufficient to say that while the cost was great the savings were vastly greater, and large stretches of growing grain were saved that would otherwise have been destroyed by the hungry grasshoppers.

After the second year in Manitoba (1920), the original species, *Camnula pellucida* Scudd., began to give way to *Melanopli*, more particularly to *M. atlantis* Riley, until eventually *Camnula* vanished and the infestation was continued by the genus *Melanoplus* alone. There was thus, in reality, a double outbreak causing a protracted infestation not at first anticipated.

Now that the outbreak is over one naturally asks what are the lessons gained? To begin with, the outbreak has provided us with the opportunity to study the insects' habits in detail. This in itself is important as an aid to devising remedial measures. We have studied them from eggs to adults and we can now not only recognize the insects in all their stages of growth but we also know their habits. This is particularly important in fighting *Camnula*, which, as is now recognized, migrates to regular breeding areas where its eggs are literally packed together in millions. It is comparatively easy to find these egg beds even after the adults have died, due to the denuded vegetation, but to find the insects in the act of ovipositing is a sight to be remembered. I do not intend to infer that there are not numerous smaller breeding places as well as the larger ones, but the species always returns from the grain fields and deposits its eggs amid the sod, selecting definite areas for that purpose.

The species of *Melanopli*, on the other hand, choose the stubble or grass fields for egg laying, ovipositing around the small bare openings rather than actually in the grass clumps. These details are naturally of importance in overcoming the insect.

We have also learnt something of the causes that lead to grasshopper outbreaks and also of the factors that control them under natural conditions.

It should be remembered that grasshoppers multiply very rapidly when conditions are right for them. A single pair may produce fifty eggs, forty-eight of which must be unproductive in order to maintain a balance. Upset this ratio by two extra survivals for each pair and the total number will be doubled. It is not very difficult, therefore, to imagine how grasshopper outbreaks begin. Dry, hot weather during the breeding seasons and an absence of natural enemies might easily multiply a normal grasshopper population into an outbreak of importance within three years.

Referring to natural enemies, it is evident that these vary in usefulness in different parts of the country and also in different years. In Manitoba, the most important grasshopper enemy was a species of bee-fly, *Systoechus vulgaris*, the larvae of which devour the grasshopper eggs. Next to this in importance were blister beetles, Sarcophagid flies and the fungous disease *Empusa grylli*. Red spiders, *Trombidium* sp., were very numerous and doubtless weakened the adults as well as destroyed many of the grasshopper eggs. A Carabid beetle, *Percosia obesa* Say, was frequently found in its larval stage amid the egg masses, and we several times reared *Scelio calopteni* Riley from individual eggs.

The wonderful part performed by Bee-flies in controlling *Camnula pellucida* in Manitoba, does not seem to have been duplicated to the same extent farther west, though the insect did valuable work even in Alberta. But, as one extended westward, bee-flies grew less important and species of Sarcophagidae became more so. This also seems to have been the case in Montana. I was in that state late last August and at that time it was almost impossible for a grasshopper to fly without being pursued by one or more of these flesh flies.

Gulls proved an important local factor in preventing and controlling grasshopper outbreaks and their value within an area of twenty miles of their breeding places can hardly be overestimated. The most important species in Manitoba was Franklin's gull.

Crows could always be counted upon to frequent grasshopper infested fields and several incipient outbreaks were checked by these birds. They also learnt to locate the *Camnula* egg beds, among which they did valuable service. Many birds feed regularly upon grasshoppers, and some, such as the Sharp-tailed grouse, depend very largely upon them as food for their young. These species are all useful in maintaining a balance, but it is to those birds that gather in flocks that we owe most when grasshoppers have got beyond their normal numbers.

Turning to artificial control of grasshoppers, it is interesting to know we have been able to check our previous findings as well as to add to them. We have learnt that mechanical contrivances for catching the insects are of small value in comparison with poisoned baits. We saw numerous spectacular efforts to burn the hoppers, catch them in machines and poison them with gas. Some people, indeed, sprayed the insects with undiluted coal oil, obtaining thereby a wonderful kill both of the grasshoppers and crop. All these contrivances proved to be merely retarders to progress and after a short time they were discarded by all experienced persons.

Of the value of poisoned baits there was no doubt even though the various authorities differed as to the best attractants. Fruit such as oranges and lemons under the formula of the Kansas bait, was used almost entirely during the first year, but later on it was discarded as too expensive in our northern latitudes. We then turned to Amyl acetate as a substitute for fruit, a substance first successfully used in Montana. Later on we cheapened our formula still more by leaving out all flavouring except salt, and during our last year's campaign we used bran, sawdust, salt and arsenic alone.

Horse droppings, the standard bait of our 1900–03 infestation, still proved to be among the best formulas, but its use was not practical with mixing machines on the scale in which baits were used in 1920. Individual farmers, however, used it with much success.

One question that has confronted us from the beginning has been the difference of opinion expressed by various entomologists as to the merits of certain attractants. There were not only differences in various states and provinces but, in some cases, at different mixing stations but a few miles apart. The variation in results at widely separated places could be explained by climatic factors and there is doubtless some reason in the explanation. As for the different results in near-by stations, we have in some cases traced the variation to the water used in mixing, which might be alkaline or not. There are times, however, when any of the usual baits are effective, a ninety per cent. kill resulting from their application. This proved a mystery for a considerable time and it has not been definitely disposed of yet, but the study of weather factors has shed important light upon the subject. We now know that temperature is one of the most important factors to be considered in bait application. It has, for instance, been long recognized that the grasshoppers do little feeding when the temperature is below 60 F. but it is only within the last three years that we have begun to draw up a definite scheme for applying bait based upon meteorological conditions alone, the chief of which is temperature. We found in our experiments that grasshoppers were practically inactive at a temperature below 65 F. in the shade even though the sun were shining. As the temperature

rose, however, the hoppers began to congregate into the sunlight to warm themselves, at 68 they began to feed in a small way and at 78 the height of their feeding activities was attained. They still ate hungrily at 85, but as the temperature rose to 90 feeding became less and the insects commenced to seek shelter from the sun. At 96 the only noticeable attractant was water, to which the hoppers came readily.

During a meeting held at Bozeman, Mont., in 1924, Mr. R. L. Parker showed a temperature chart in which the grasshopper activities had been worked out in detail. This chart agrees very closely with my own findings and indicates that we are in close agreement on this important subject.

There is no doubt that loss of material and great waste of time have resulted from a lack of knowledge as to the best time to apply baits, and there is reason to suspect that most of our failures have been due to this cause.

To put out bait before breakfast when the temperature is far below the grasshoppers' feeding range may seem to save time but in reality it means that the bait has largely dried out before the insects are ready to feed and on this account it has become to a great extent unpalatable and valueless.

The wonderful kills with any kind of bait are thus explained. The baits were accidentally put out at the right time. I may add that we consider sunlight a desirable factor to success in applying baits, though it is not actually necessary if the temperature is high enough.

Lastly, we have substituted mixing machines for the old slow hand mixing, in this way not only saving time but also ensuring an even mix. These machines were situated at strategic points where strict account was kept of the amount of bait supplied to each farmer, and each got a just share in accordance with his requirements. This phase of the work was under the direct supervision of the Provincial Department of Agriculture, to whose officers the highest praise is due.

THE ROSE CHAFER AND FARM MANAGEMENT

William A. Ross and J. A. Hall, Dominion Entomological Laboratory, Vineland Station, Ontario

During the past three years we have conducted an investigation on the rose chafer problem in southern Ontario, particularly in Pelham township, Welland county, and this investigation has demonstrated, we believe, that fundamentally the control of the rose chafer is a matter of farm management. It is true that spraying with sweetened arsenate of lead* has proved to be of value—it will protect grapes and other plants from the ravages of the insect—but we have found that spraying has serious limitations. It is unduly expensive, where more than one application has to be made; plants with nearly ripe fruit and certain ornamentals cannot be sprayed; but most important of all, experience has shown that, on account of the omnivorous habits of the beetle, the spraying of vineyards and orchard trees here and there throughout an infested district will never reduce the insect to small proportions. Spraying is of value, but let us make this point clear, we consider it of value only as a means of protecting certain plants from serious injury until the chafer has been brought under control by the farm methods discussed herewith.

*Arsenate of lead powder 3 lbs., cheap molasses 1 gallon, water 40 gallons.

Effect of Spring Cultivation

Early spring cultivation or, to be more specific, cultivation done prior to the pre-pupal or dormant stage of the insect, has little or no effect in reducing the chafer population. A few grubs may be crushed by the plough or other implement, but the vast majority escape without injury, those turned up by ploughing being sufficiently active to "dig themselves in" rapidly. Furthermore, at the time the earliest cultural work is done, many of the larvae are still below plough depth.

We have abundant evidence, however, that ploughing and cultivating in late May and early June, during the period the chafer is in the pre-pupal and pupal stages, are very fatal to the insect. In 1923 a badly infested field was ploughed on June 7th and 8th at which time approximately 92 per cent. of the grubs had pupated—and on the two successive days it was disked and harrowed. This cultivation reduced the average chafer population from 93.66 insects per square yard to 27.33, or, in other words, it was responsible for a mortality of approximately 70 per cent.

In 1924 a neglected sod field with an average grub population of 150 per square yard was ploughed on May 26th, 27th, 28th, and was then disked three times at intervals of five days. After cultivation the average chafer population was secured in two ways: (1) By taking a census of the insects in 11 square yards in different parts of the field, and by trapping the chafers in six large cages. Both methods gave approximately the same population per square yard namely, 14.7 in the first case and 15. in the other, showing that cultivation had accounted for approximately 90 per cent. of the insects. In another field—oat stubble—ploughing, disking and harrowing in late May and early June reduced the chafer population from 182.6 to 47.6 per square yard, or, in other words, destroyed approximately 74 per cent. of the insects.

Effect of Cultivation on Eggs

Insectary experiments and field observations indicate that eggs in the absence of moisture, e.g., eggs exposed to the sun and wind, and eggs in dry soil, fail to hatch, and furthermore that newly hatched larvae succumb when exposed to the sun. Advantage may be taken of this by ploughing and disking in July when the majority of the eggs have been deposited.

In 1923 part of a neglected sandy field well stocked with eggs was ploughed on July 11th, and was then disked three times on July 14th, 25th and August 13th. The other part was left untouched as a check. A census of the grub population in the cultivated and check plots gave the following results: Cultivated land—121 grubs per square yard; Check—520 grubs per square yard, indicating that cultivation had destroyed in the neighbourhood of 76 per cent. of the eggs or newly hatched grubs.

During 1924 similar experiments were conducted on a larger scale in one field at Fenwick and in another at Ridgeville. In both instances several strips of land about 20 feet wide were ploughed and then disked three times at intervals of 3 to 4 days, and "check" strips alternating with the cultivated lands were left uncultivated. In the experiment at Fenwick the average grub population per square yard in the check was 112, whereas in the cultivated strips it was 39, indicating a reduction of 65 per cent. At Ridgeville the figures were 208 grubs per square yard in the check, and 60.6 in the cultivated land, indicating a reduction of 71 per cent.

Effect of Fall Ploughing

The experiments on the effect of fall ploughing, which are summarized herewith, demonstrate that late fall ploughing has a marked effect in reducing the grub population.

Exp. No.	Ploughed	Fall population per sq. yard	Spring population per sq. yard	Approximate per cent. reduction
1	October 15th (early)	190.5	167.2	12.3
2	October 22nd	108.6	71.3	34.36
3	November 15th	224	129	42.96
4	November 15th	77.2	37.2	52
5	November 16th	105.6	52.8	50

In each of the five experiments referred to in the table, a census of the grub population in the "checks" made in the fall and again in the spring showed no appreciable reduction in chafer population—the highest percentage of mortality being 2.04 per cent.

Ecological Factors and Control

In conducting surveys of rose chafer breeding grounds, we have observed that the insect does not occur in clay, clay loam or in gravelly soils; that it is not present in land shaded by trees, and that it does not breed to any appreciable extent in clover sods. In connection with clover sods, we found in 1923 that in localities where the grub population in grass land averaged 190.2 per square yard (40 square yard examinations) it only averaged 13.8 per square yard (16 square yard examinations) in clover—red, sweet and alfalfa. Further evidence that the chafer does not breed to any extent in clover was secured by making "paired counts," that is, each examination made in clover was duplicated in the adjoining field of grass, stubble or weeds. This yielded the following results: Grub population in clover, 3 per square yard; grub population in check, 121 per square yard.

In the 1924 survey the grub population in grass lands was 128.6 (108 square yard examinations), whereas in clover sod—red, sweet and alfalfa, it was only 5 per square yard (30 square yard examinations). In one instance, three grass sod examinations yielded 1,432, or 477 per square yard, and 3 examinations in the adjoining red clover yielded only 28 larvae, or 9 per square yard. In the Simcoe district "paired counts" gave the following results: 18 square yards sod yield 2,742 larvae—152 per square yard, whereas, in the adjoining clover, the population was only 140 or 8 per square yard.

The Application of Farm Methods of Control

We have learned that the plough, disk and cultivator are the most important weapons in fighting the rose chafer, and that these weapons can be used most effectively at three different times, namely, in late May and early June, or, in other words, at the time land should be prepared for corn and potatoes; in mid-July when land should be prepared for buckwheat, and when old strawberry patches should be ploughed under; and in late fall when ploughing is commonly done. We have likewise learned that the insect does not occur in land shaded by trees; that it does not breed to any appreciable extent in cultivated crops or in fields of clover. How are we going to utilize this information

in combating the rose chafer? First of all we have to take into consideration the most important breeding grounds of the insect, viz.: the waste, sandy land; the idle farms, and the vacant lots and fields held for speculative purposes, some of which are found in every district where the chafer is a serious pest. The most important and unfortunately the most difficult step in fighting the rose chafer is the reduction of these favorite breeding grounds to a minimum. There are three methods of dealing with neglected sandy lands, at least one of which should be practicable in any chafer infested section:

(1) Bring it under cultivation.

(2) Seed it down to alfalfa or sweet clover.

(3) Reforest the land if it is worthless for agricultural purposes. While reforestation will not afford immediate relief, it will in time, when the trees are large enough to shade most of the ground, make the land wholly unsuitable as a breeding place for chafers. Apart altogether from rose chafer control, it should be the policy of private owners or of municipalities to reforest waste sandy land and convert what is worthless and ugly into something profitable and beautiful.

In addition to the reclamation of waste sandy land, old neglected fence rows should be broken up, and all vineyards, orchards and berry patches should be kept well cultivated. Cultivated crops such as corn, potatoes and strawberries should be grown to the greatest extent possible on the land surrounding the vineyards and orchards, and in the crop rotation clovers should be wholly substituted for grasses. Roadsides should be cultivated up to the ditch, or if this is not possible, shade trees should be grown along the roadside. The fundamental methods of controlling the rose chafer are, in brief, clean farming, good farming and the substitution of clovers for grasses.

THE LILAC LEAF MINER

Gracilaria syringella Fabr.

C. B. Hutchings, Entomological Branch, Ottawa

Economic Note: The lilac is one of the commonest and most beautiful of our ornamental shrubs. Its fragrant blossoms, which in early springtime hang in heavy clusters ranging in colour from white to shades of purple, red and lilac, make it extremely popular and an object of admiration to all flower lovers. While there are several species of lilac in cultivation, the common lilac, *Syringa vulgaris*, and its large number of varieties, are best known. On account of their satisfactory foliage of many rich green shades which last throughout the summer months, their hardiness, ease of cultivation and general adaptability, they are specially prized throughout Canada and are found thriving in backyard lots equally as well as on lawns and extensive gardens where they often act as useful hedges and windbreaks.

History of Lilac. The lilac is a native of Europe and Asia. It belongs to the genus *Syringa* of the Olive family Oleaceae. There are several original varieties of *Syringa*, the principal being *vulgaris*, the common lilac, and *persica*, the Persian lilac. The word lilac is from *lilag*, the Persian word for flower. *Syringa* is from *sirinx*, which is the native name given to this plant in Barbary, a district on the Northern Coast of Africa.

The plant was introduced into England for cultivation about 1597. It is

not known, however, when it came to this continent, but there are records of it being here as early as 1652, and it is highly probable that immigrants were responsible for its spread later to western America.

Observations. For the past two summers, at least, the lilacs in many parts of Ontario have been attacked by an insect enemy which has severely damaged the foliage, thereby ruining the beauty and symmetry of many of these ornamentals.

My attention was first drawn to this insect during the summer of 1923. I had occasion to visit the Victoria Museum, Ottawa, some time in the month of August, and noticed the lilacs about the grounds there badly infested with a leaf miner. Curiosity led me to examine other shrubs of this kind in neighbouring gardens on Frank and Metcalfe Streets, and to my surprise found also that those of the central residential sections of the city, the Driveway and the Central Experimental Farm showed the infestation, thus indicating a general local outbreak.

Specimens of the injured leaves containing larvae were brought to the laboratory for closer study. From this material there emerged the following spring (1924), a species of moth which was identified by Mr. J. J. deGryse, of the Entomological Branch, as *Gracilaria syringella* Fabr. and one considered to be a very serious European pest on lilacs. Just how and when this insect came into Canada is not definitely known, however.

As the summer advanced complaints began to come in from various parts of the city, and later on at both our Ottawa and Toronto Exhibitions a number of inquiries were received respecting this trouble.

In the meantime life-history studies and some control esperiments were carried out. I was assisted in these investigations by Mr. A. R. Graham; and through the courtesy of Mrs. E. J. Chamberlain of 333 Metcalfe Street, we were permitted to conduct our observations and experiments on the lilac hedges in her garden.

Character of Injury. About the end of the third week in May the moths emerge and deposit their eggs in groups of from five to ten on the undersides of the leaves, next to the axils of the veins. The caterpillars hatch in a week's time and bore upward into the leaf, feeding upon the parenchymatous tissues between the upper and lower epidermis.

The point of feeding at first appears simply as a discoloured spot; but this soon becomes irregularly enlarged, and since there may be several of these spots on one leaf, and due to the number of larvae around each, they spread and soon coalesce, giving the leaf surface that characteristic bladdery appearance. After feeding this way for three weeks the larvae come to the exterior and curl the leaves. This is generally done from the apical end, although side rolling is not uncommon. The roll is held in place by several strands of white silk fastened down on the exterior, and the larvae which still retain their gregarious habit feed from within on the upper surface of the leaf as they roll it. In ten days they mature and leave the roll, letting themselves to the ground by a fine thread and pupate in the rubbish or surface earth. This resting period occupies approximately two weeks. A second generation then emerges and attacks the leaves more severely than the first, with the result that the foliage is often completely destroyed. The time occupied for the entire life-history is a little over seven weeks. The first generation terminates about the third week in July and the second continues towards the middle of September.

Description. The moth belongs to the Microlepidoptera and to the family Gracilariidae. The body is dark brown in colour and about 4 mm.

long, with a wing expanse of 1 centimeter. The uppers are of brownish tint, splashed with six yellow, irregular, transverse patches. The under wings are grey-brown and fringed with light grey, very fine hairs. The moths fly during the early hours of the evening.

The larval part of the life-history may be divided into two stages, viz.: mining and skeletonizing. In the mining stage the body of the larva is of a greenish tinge, quite transparent, glossy and covered with numerous fine, long hairs. The prolegs are wanting. Later in the skeletonizing stage it becomes a faint, yellow colour through which the intestinal tract is clearly defined. A full grown larva is approximately 8 mm. long, i.e., a little over ¼ inch, and 1½ mm. broad. The body, over which a number of sensitive spines are arranged, is cylindrical and somewhat spindle shaped. The head is brownish-yellow, quite conspicuous, smooth, sloping and somewhat compressed. The antennae have three joints. The ocelli, which are arranged in a semi-circular manner, are six in number. The true legs are three-jointed and each bears a tarsal claw surrounded at the base with fine bristles. On the third, fourth and fifth body segments are the false or prolegs, each crowned with a wreath of hooked feet pointing forwards. The anal pair on the tenth segment is semi-circular and also points towards the head. On the ninth segment are several extra long spines which are arranged obliquely and directed outward and backward.

The pupa is about 4 mm. long and yellow in colour, enclosed within a thinly spun cocoon of white silk which the caterpillar fastens to the earth, board or rubbish where the transformation is to take place.

CONTROL. Several strengths of nicotine sulphate were used. While one to one and a half tablespoonfuls to one gallon of water was found hardly strong enough for all stages of the larvae, that of two tablespoonfuls to the gallon effected a perfect control. Not only did this strength kill all the larvae in the mines, but it reached and destroyed those within the rolled leaves. It was observed that the poisoned liquid was supported on the curling leaf surfaces and later was drawn gradually into the roll and readily affected the feeding larvae. The time to spray is when the leaves first show signs of being spotted, early in June, using one and a half tablespoonfuls of the nicotine to one gallon of water. Follow this with the stronger solution two weeks later, if necessary. The material should be applied as a fine spray and the branches well covered above and below.

The picking of the spotted leaves early in the season and burning these may hold the pest in check to some extent. While this plan lends itself conveniently in treating small shrubs, it is obviously too tedious and impracticable for the larger plants and high hedges.

SOME VARIETIES OF *Syringa vulgaris* SHOWING VARIOUS DEGREES OF ATTACK BY *Gracilaria syringella* F.

In making observations in the Arboretum at the Central Experimental Farm, Ottawa, where over 150 varieties of this shrub are being grown, it was observed that the miner showed a marked partiality for some varieties, while on the other hand it avoided others entirely. The following list, which it was found convenient to divide into four parts, will illustrate this, and the name of the different varieties examined are recorded below. It must be understood, however, that this list is made for the year 1924, and is, therefore, only suggestive.

Heavily Infested.

Madame J. Morel	Madame Moser	Macrostachya
Rouge de Marley	Ruba insignis	Belle de Nancy.
Purpurea	Monument Carnot.	

Lightly Infested.

Prinz Notger	Charles X	Auvergne.
Princess Maria	Volcan	Renoncule.
Dr. Linley	Furst Liechtenstein	Charles Joli.
Prof. Sargent	Senateur Volland	Double Blue S. sibirica.

Very Slightly Infested.

Jacques Calot	Eckenholm	Congo.
Amethyst	Bulgaria	Edward Andre.
De Miribel	Lovaniensis	W. M. Robinson.
	Madame Casimir Perier.	

Not Infested.

Dr. Nobbe	Montgolfier	Marie Le Graye.
Virginite	Vergissmeinnicht	Chas. Baltet.
Rene Jarry Desloges	S. Murillo	Mad. Abel Chatenay.
Geheimrath Singlemann	Delepin	Emilie Lemoine.
Michel Buchner	President Carnot	Obelisque.
Alba grandiflora	Comte Horace de Choiseul	Versaliensis.
Negro	Croix de Brahy	Madame Briot.

FORMER RECORDS. No traces could be found of *Gracilaria syringella* in the United States records, and there seems to be only one brief note from Canada. This appears in the fifty-fourth Annual Report of the Entomological Society of Ontario for 1923, on page 62, under the heading, "Insects of the Season," by Messrs. Caesar and Ross. It reads as follows: "Lilac leaves severely mined by some insects were received from several places in Toronto, Newcastle and Guelph. Leaves were sent in on June 16th, 28th, July 31st, and August 10th, and complaints were made at the time that if this pest increased it would make lilacs so unsightly they would be better removed. The larva was lepidopterous and possibly the same one that has troubled lilacs in England, viz.: *Gracilaria syringella*."

Two English investigators, Collinge and Gillanders, have short accounts of the life-history, and Truffaut, a French entomologist, at Versailles, in his "Les Ennemis des Plantes Cultivees," devotes a short paragraph on page 377 to a discussion of this insect. Other French and German entomologists have studied this insect at different times, and a list of the principal references has been added at the end of this paper.

Besides feeding upon lilac, *Gracilaria syringella* has been recorded on Ash, Privet and Eyonymus (spindle tree) and Deutzia.

References

Fifty-fourth annual report Entomological Society of Ontario, p. 62, 1923.

Manual Injurious Insects, by Walter Collinge, Birmingham, Eng., *G. syringella*, the Lilac Leaf Miner, p. 173, 1912.

Forest Entomology, A. T. Gillanders, p. 280, 1908.

Les Ennemis des Plantes Cultivees, pp. 377; Geo. Truffant, Versailles, France. A brief life-history note, 1913.

Trait d'Entomologie Forestière, pp. 539, Recorded on Ash, 1913.

Judeich Nitsche, Forst Insecktenkunde, Vol. 2, p. 1066, recorded on ash.

Die Raupe der Fliedminiermotte, *G. syringella*, Von Dr. L. Fulmek, Vienna, 1910.

Die Feinde der Syringin, from Die Gardenwelt, Berlin XXVI, 21, 1922, Enemies of the Lilac including *G. syringella*.

Report on Insect Pests and Fungus Diseases of Field and Orchard in 1920. Tidskrift for Planteavl Copenhagen, Denmark, *G. syringella* on lilac and privet in Denmark, 27, 1921, pp. 697-759.

A communication on diseases and pests of cultivated plants in Bohemia in 1918. Zemedelsky, Arch, Prague, Austria, 1920, pp. 80-96, 195-202. *G. syringella* abundant near Prague, Austria.

Handbuch der Pflanzenkrankheiten, by Prof. Dr. P. Sorauer, p. 248, 1913.

Les Insectes nuisibles, Vol. III, p. 105, by Ch. Goureau, 1861.

Entomologie et Parasitologie Agricoles, by G. Guenaux, p. 394, 1917.

PROF. CAESAR: There were some badly affected hedges in Guelph. I saw one about 40 feet long and practically every leaf was dead by the end of July. I think there is some possibility that arsenate of lead might control this pest but I am very glad to hear that Mr. Hutchings has had good success with nicotine sulphate.

NOTES ON THE OCCURRENCE OF THE LESSER GRAPEVINE FLEA-BEETLE IN CANADA

ARTHUR GIBSON, OTTAWA

An interesting outbreak of this insect occurred in Ottawa city in June, 1917. In the same year, and in other years, Mr. Dwight Isely found the insect in numbers in the State of Pennsylvania, studies being made at North East, Pa. The species was found to be undescribed and the name of *Altica woodsi* was given to it by Mr. Isely. A description of the insect, with a biological account, was published in Bulletin No. 901, U.S. Department of Agriculture (December, 1920).

The Ottawa outbreak is the only one of which we have record in Canada. In that year, the larvae and beetles were found in considerable numbers on the foliage of Virginia creeper. On June 8th, numerous eggs were seen to be present on the leaves. These had been deposited singly near the larger veins, as noted by Isely. In three instances at Ottawa, two eggs had been deposited close together. Nineteen eggs were counted on one small leaf 3¼ inches long by 2¼ inches wide; on another leaf, 3½ inches long by 2½ inches wide, twenty-six eggs were counted. The eggs lay flat upon the leaves and as has been recorded with other species, were streaked lengthwise with a thin line of excrement. My notes state that the colour of the eggs is of a pale orange-yellow; the above author gives the colour as "straw yellow."

Eggs collected on June 8th, hatched on June 15th. By June 30th many of the larvae were mature and were entering the earth. Pupation took place near the surface. One larva made its cell one-half an inch below the surface. The mature larvae were yellowish-white in colour and measured 6 mm. in length. In our breeding jars the larvae fed almost exclusively on the undersides of the leaves.

Examples of both sexes of the beetles which emerged from this brood of larvae were confined in a breeding jar in an outdoor insectary and eggs were deposited freely on and about August 15th. This would suggest two generations in the Ottawa district, at least in some years. According to the above author there is in Pennsylvania only one generation, the insect passing the winter in the adult stage. Regarding the Strawberry Flea-beetle, *Altica ignita*, Ill., Chittenden (Bull. 23, N.S., U.S. Bureau of Entomology) states that indications pointed to two generations annually in the District of Columbia and that there was probably a third generation in the south. Most of the species in this genus, however, apparently have only one annual generation.

Regarding the adult, Isley says that it "is similar to *Altica chalybea*, from which it may be distinguished as follows: Colour, metallic green, rarely with purple or olivacious reflections; antennal joint 3 equal in length to joint 4; average length 3.05 mm., varying from 2.43 to 3.05 mm. The Ottawa specimens collected on June 8th and those which I reared from eggs are all either bluish or greenish in shade with, of course, the metallic reflection.

The outbreak at Ottawa is the only one of economic interest which we

have from Canada. In the Canadian National Collection of Insects we have the beetle from the following additional localities:

Montreal, Que., 12 June, 1906 (G. Beaulieu);
Aylmer, Que., 24 August, 1923 (C. B. Hutchings);
Trenton, Ont., 17 August, 1902; 24 June, 1906 (J. D. Evans);
Bowmanville, Ont., on grape, 19 June, 1913; 3 Aug., 1913; 8 Sept., 1913 (W. A. Ross);
Beaumaris, Ont., 26 June, 1917 (G. Beaulieu).

All of the specimens have been examined by Mr. Norman Criddle, of the Dominion Entomological Branch, who considers them to be the species under discussion.

Our records indicate that the insect in Canada has been found on Virginia creeper and cultivated grape. In Pennsylvania wild grape is also attacked.

PROF. CAESAR: I would like to add that several years ago I found this species on wild grapes in Prince Edward county. Both adults and eggs were easily found on the leaves.

NOTES ON INSECT PARASITES OF PHYLLOPHAGA ANXIA IN THE PROVINCE OF QUEBEC

By C. E. PETCH AND G. H. HAMMOND, DOMINION ENTOMOLOGICAL LABORATORY, HEMMINGFORD, QUE.

For the past ten years or more white grubs have caused serious losses to various field and garden crops in the Province of Quebec. In Southern Quebec during the summer of 1923, areas of 100 square feet were found upon which no vegetation survived, and from such areas 50 white grubs per square foot of surface were collected.

During the past summer a study was made of the insect parasites of *Phyllophaga anxia* to determine the species which were important as white grub control factors and to what extent they were effective. As investigational work was started toward the end of June it was impossible to secure adult parasites. We are hoping, however, to secure a plentiful supply of these following the heavy flight of adults expected to appear during the spring and early summer of 1925.

Tiphia inornata Say.

Few adults of this species were on the wing this season and from collections made at Hemmingford and Ste. Anne's, no other species of *Tiphia* was obtained. Parasitism ranged between 3 and 49 per cent. in local areas, being determined by collections of infested grubs and *Tiphia* cocoons. From muck soil collections, parasitism averaged 4.4 per cent.; in loose well drained gravel soil containing considerable sand, 20.8 per cent., and in sandy loam soil seeded to timothy and not ploughed for three years, 16.6 per cent. The average control from all types of soil, determined from 13,480 *Phyllophaga* larvae in various stages, was 13.2 per cent.

Although many cocoons of *Tiphia* were collected during the summer, few adults emerged and only a few were noted on the wing. Hence only a few larvae were found attached to the white grubs. They were found always in a transverse feeding position near the mid-dorsal line of the prothoracic segment of the grub, which is closely related to the position occupied by the eggs

of *T. punctata* Rob. (1). This position was unaltered until the parasitic larvae were almost full grown, when the host became flabby and distorted as a result of the feeding of the parasite. The above statements differ from those of J. J. Davis (1) in reference to *T. inornata*, which are as follows:—"the eggs are laid on the underside of the thoracic or first abdominal segments, usually between the second and third thoracic segments and to one side of the median line, not infrequently relatively distant from the median line and between the legs."

Markings from *Tiphia* stings and larvae were located on the dorso-median area of the prothorax of the grub, except in two cases where they were attached to the mid-dorsal area of the metathorax. Usually the egg was deposited in the depression of a fold. The larvae hatched from eggs did not reach maturity, but from partially grown larvae collected in the field it was noted that an increase in length of 5 mm. commonly took place in twelve days. In the field larvae were noted in various stages of development between July 25th and October 28th. Cocoon construction was noted between July 28th and September 19th. There is a distinct prepupal stage within the cocoon before the pupa is formed in which the larva assumes a compact form.

Hibernation occurs mainly in this prepupal stage within the cocoon. In a series of 500 cocoons collected in the fall, 85.8 per cent. were over-wintering in this stage, .6 per cent. in the pupal stage, and 13.6 per cent. of the same series hibernated in the adult stage. From our present knowledge it is difficult to state the duration of the life cycle in the Province of Quebec, but there is a possibility that it occupies more than one year. There were no hyperparasites reared from this species.

Pelecinus polyturator Drury

This species is not uncommon in the Hemmingford district and at Aylmer, Que. Two females were dug out of soil heavily infested with white grubs on August 25th at a depth of six inches but no trace of immature stages could be found.

Microphthalma phyllophagae Curran

During 1924 large white maggots with prominent black posterior spiracles were reared in considerable numbers from parasitized white grubs. In two cases three were present in a single host but in all other cases a single larva was found in one white grub. Adults of these parasites were assumed to be *M. disjuncta* Wied., but Mr. C. H. Curran indentified them as an undescribed species of which a few specimens were present in the Canadian National Collection from Ottawa district and Covey Hill, Que. This species has since been described by Mr. Curran as *Microphthalma phyllophagae*. Evidently *M. disjuncta* is absent, because, out of a large series examined, all flies were *M. phyllophagae*. Additional distributional points from material in the Canadian National Collection are Aylmer, Que.; Teulon, Man.; and Fredericton, N.B. No hyperparasites were reared from this species, but the spider, *Aglaope trifasciata*, a common species in meadows in the Hemmingford district, was found to be predaceous on the adults.

The comparative abundance of *M. phyllophagae* this season has probably resulted from a moderate degree of parasitism of white grubs during the season of 1923 when the latter were in their second year, with the exception of a small overlapping series. White grubs were so abundant in the soil that the percentage of *Microphthalma* larvae which survived and managed to reach a white

grub was relatively high. Hence the abundance of flies on the wing during the year 1924. Doubtless the number of flies on the wing during 1925 will be smaller because of the decrease in the number of hosts in the soil due to pupation and adult formation during the larviposition period. The eggs hatch within the fly and the living maggots presumably are deposited on the surface of the soil or in crevices.

In a series of 295 white grubs collected in the last week of June from gravelly and sandy loam soil 11.8 per cent. were parasitized. In sandy loam soil which was planted to timothy for the past four years a collection of 155 white grubs obtained October 23rd were parasitized to the extent of 9.8 per cent. The highest percentage of infestation was found among grubs collected from loose muck soil. Collections of 181 grubs from this area were 15.4 per cent. parasitized. The above type of soil is believed to be ideal for the successful establishment of the parasite within the host.

Pupation began July 6th and was at its height on July 13th but puparia were found until July 24th. There were little external signs of parasitism in the colour or shape of the grub. The caudal extremity of the parasitic maggot projected through a large opening in the ventral side of the grub, which allowed the escape of much of the body fluid remaining in the host. Puparia were formed either within the body of the grub or at a short distance from it and they were frequently found in empty white grub cells in the field with the larval skin of the host attached. Adult emergence commenced in the laboratory on July 26th and was at its height on August 16th but continued until August 25th.

The rapid short flights of the species in the field, accompanied by a low, voluminous, droning sound, was first noted in the field on August 8th but as the flies were present in considerable numbers they were probably on the wing from the first of the month or slightly earlier. Late captures were made on October 2nd but it was common to find specimens with badly frayed wings during the early part of September.

Females kept in vials in the laboratory deposited living larvae and a certain number of eggs from which larvae emerged almost immediately throughout the period August 13th to October 1st. Larviposition is believed to be normal under field conditions, although J. J. Davis (1), in referring to *M. disjuncta* Wied. speaks of oviposition as the normal method of reproduction. Beaver meadows and pastures were favorite habitats for the flies but they did not seem to be attracted to flowers. Although difficult to see in their rapid flight their dark colouration renders them easily visible on green foliage.

Collections made during mid-day contained a considerably greater proportion of males than females but in evening collections and in a series of specimens reared in the laboratory the proportion of sexes was about equal. Hibernation occurs within the host when the young larvae are from 1 to 3 mm. long, development proceeding slowly during the latter part of the season.

The adult is a stout fly approximately 13 mm. in length with long legs furnished with large tarsal claws. Long black bristles occur over the abdomen and thorax and the legs are armed with short bristles. The female can usually be distinguished from the male by her darker colouration and by the short pseudo-ovipositor. The vagina contains mature eggs and young larvae to the number of from 350 to 550. Under artificial conditions never more than 225 eggs and larvae were deposited by a single female but under field conditions, however, it is probable a greater number are commonly deposited.

Both eggs and young larvae are tightly packed in the vagina at right angles to its length. The egg is .8 mm. long, curved to each extremity. The anterior

extremity is sharply pointed while the posterior extremity is usually bluntly pointed. A semi-transparent almost circular area occurs just beneath either extremity. Young larvae just out of the chorion are light yellow in colour, from .8 mm. to .9 mm. long, slender, tapering from the anterior to the posterior extremity. They progress rapidly with a partial looping movement and at regular intervals throw the head end violently into the air and wave the body back and forth while maintaining the equilibrium with the extreme caudal part of the body. Actual entrance of the young parasite into the grub host has not been observed but the young larvae have frequently been observed beneath the white grub cuticle. Their progress through the host tissues is typically marked by an elongated dark brown streak which generally originates on the lateral area near the centre of the grub and continues after some sinuations across the dorsal area. Usually the young parasite is found near the end of the brownish streak, but in a number of cases cannot be found at all. Some of these brownish areas are rounded but the brownish colouration is usually streaky and it may appear granular because of the presence of many small brownish spots. It is usually irregular in form and in most cases the larvae can be seen. On the other hand, lesions of *Micrococcus nigrofasciens* (2), a bacterial disease with which it might be confused, are rounded, black to dark brown in colour. It is very probable that in many cases the young parasite introduces the disease into the white grub host when becoming established, but this point has not been definitely determined.

The mature larva is approximately 16 mm. long and 4.5 mm. wide. The head extremity, which is bluntly pointed, bears the anterior spiracles with their multiple, rounded openings. The caudal extremity is truncate and somewhat oblique. Near the central area of the caudal extremity are the two large, black, prominent spiracles, each of which has three raised, rounded ridges. The three openings are narrow, elongate and almost parallel. The anterior half of the six forward segments are armed with numerous rows of short, stout, pointed spinulae which decrease in size toward the caudal extremity and cover the greater part of the surface of the posterior segments.

The puparium is rounded and cylindrical, approximately 12 mm. long and 4 mm. in diameter. The anterior extremity is roundly pointed and the posterior is bluntly pointed. The spiracles differ considerably in form from those figured for *M. disjuncta* Wied. by J. J. Davis (1).

Asilidae

Asilid larvae were noted in several instances to feed on white grubs in rearing tins. They were moderately common in a number of fields, which were badly infested with white grubs. Timothy sod, which had not been ploughed for several years, seemed to be the favorite habitat. A total of 325 larvae were picked up behind the plough over the same area from which 13,655 white grubs and June beetles were collected. No adults have yet been reared, but in the laboratory collection *Asilus paropus* Walk., *Cyrtopogon falto* Walk., *Asilus novaescotiae* Macq., and *Asilus erythrocnemius* Hine are the most numerous. Other species not so numerous, but which are liable to be predaceous in the larval stage, are *Asilus notatus*, *Asilus snowi* Hine and *Asilus sadyates* Walk.

Mites

Although not properly classified as insects, mites may be included here, because of the occurrence of one species which has been found on 100 per cent. of the grubs in Hemmingford district.

All the grubs were infested with the hypopial nymphs of a species of Tyroglyphus. These nymphs are .3 mm. in length, broadly oval in outline, and shaped like a flattened scale. Two anterior pairs of legs are slender and taper to the tarsi. The beak is moderately distinct and pointed. The posterior pairs of legs project backwards and are smaller than the anterior pairs. In the living mite the colour is uniformly straw-colour or white, but in specimens boiled in caustic potash a round, deep brown spot may be seen on either side of the body near the median area, which apparently is not present in the more immature specimens.

In the case of moderately infested white grubs the greater number of the nymphs are grouped around the legs. In badly infested specimens hundreds of mites may be found distributed over the host, closely attached to the cuticle by both the beak and legs. Asilid larvae are infested in rare cases by this species, which prefers the living host but does not abandon the host when it is dead. They do not feed in this stage, according to Dr. Banks, but are carried about by the insects until they reach a suitable breeding place, and further, they feed upon fungus and decaying vegetable matter and are never predaceous.

A species of mite which is not very numerous is *Rhizoglyphus phylloxerae* Riley. It is 1 mm. in length, broadly oval in body outline, white and without markings of any kind. The legs are long, stout, with moderately long claws. The sucking beak is prominent, fairly broad at the base, and tapers to the apex. It is seldom found attacking live white grubs and occurs in small numbers, seldom more than a dozen being found on a single grub, pupa or beetle. Frequently, decaying vegetable matter is taken as food.

White Grub Saprophytes

Ophyra leucostoma Wd. and *Muscina stabulans* Fallen were found in large numbers in dead white grubs which were exposed, but neither species was observed to be parasitic, even under exceptional conditions.

Literature Cited

(1) Davis, J. J., Sta. of Illinois, Dep. Reg. and Education Div. of Nat. Hist. Surv., Vol. XIII, Art. V.

(2) Northrup, Zae, Mich. Agr. Exp. Sta., Tech. Bul. 188.

NOTE ON PTINUS FUR L. AND VILLIGER REIT. AS STORED PRODUCT PESTS IN CANADA

C. Howard Curran, Ottawa, Ont.

During the past summer reports of injury to stored flour in the Prairie Provinces by a beetle not previously recorded as causing serious damage have come to hand. Unfortunately living specimens were not secured in sufficient time to conduct experiments tending to the formulation of control measures or to work out the life history of the insect, which proved to be *Ptinus villiger* Reit., so that it is intended here to give notes regarding the occurrence and the products attached.

Ptinus fur L., has also been reported as attacking flour and other stored products and, according to Mr. Wm. Downes of the Dominion Entomological Laboratory, Victoria, B.C., the beetles were troublesome in his house, infesting

such stored products as bran, shorts and grain. They also proved to be a pest to Museum specimens, having attacked insect specimens and stuffed birds. *Ptinus fur* has been recorded from time to time as a household pest attacking various stored products and is commonly known as the "Spider Beetle" on account of its appearance.

Ptinus villiger Reit. appears to be responsible for the damage to stored flour, etc., in the Prairie Provinces, no specimen of *P. fur* having been received during 1924, associated with stored mill products from this region, although it occurs on the prairies (see distributional note below). *P. villiger* is distinguished from *fur* by the presence of much longer, rather bristly hairs on alternate intervals of the elytra, these hairs being sub-equal in length in *fur*.

The products attacked by *villiger* on the prairies are: flour, farina and cornmeal, according to Dr. A. W. Alcock, chemist of the Western Canada Flour Mills, Winnipeg, who has also made observations on the life history. According to his observations, which he describes as very casual, he placed a few beetles in a sealer with some cornmeal, and while the beetles died, a new generation emerged in about three and a half months. This gives some idea of the time required to complete the transformation from egg to adult under favorable conditions, a temperature of about 85 degrees Fahr. being maintained.

The eggs have not been seen. The larvae are yellowish white, small, robust, curved and very densely covered with erect, soft, whitish hair. The head is mostly brown, and the eyes are covered with dense hair as on the body. The adult varies in colour from reddish brown to deep brownish black, with, normally, a patch of whitish, recumbent scales on each elytron near the base and apex.

The damage to flour is rather characteristic: the flour becomes granular or flaky and may even be somewhat "stringy" when the infestation is unusually severe. The full-grown larvae form a ball of flour in which they pupate, and these may be found in numbers at the proper stage of the development of the insect.

Distribution of *Ptinus villiger* Reit., as shown by specimens in the Canadian National Collection. Estevan, Sask. (material for rearing, etc.); Aweme, Man., and Ottawa, Ont. Leng gives "Nfld., Can., Wash." (Since either *P. fur* or *villiger*, probably the latter, is proving quite troublesome in Minnesota, it is almost safe to include that State in the list.) Blatchley gives: "New England, Michigan and westward."

Distribution of *P. fur*. Material before me is from the following localities: Ottawa, Ont.; Aylmer, Que.; Medicine Hat, Alta.; Lillooet, B.C., and Victoria, B.C. Leng gives: "Cosmop., Ind.; Alaska, Eur., Asia." Blatchley gives: "Hamilton and Posey Counties (Indiana); scarce."

WARFARE AGAINST THE INSECTS

C. L. METCALF, DEPARTMENT OF ENTOMOLOGY, UNIVERSITY OF ILLINOIS

A distinguished chemist recently told me that "the corrosion of iron,—ordinary *rust*—costs *the world* about *$200,000,000 a year*." I assured him that the *corrosion by insects* costs the people of *this continent* alone, at least *$1,000,000,000 a year*, or five times the loss by iron rust for the entire world.

The general run of the American people are very indifferent to this tremendous loss. Entomologists have been warning us for years that the insects are our greatest rivals for the control of the natural resources of the world, and constitute a greater menace to future generations than the yellow peril, or the black peril, or any other human peril that has yet been uncovered. Professor Stephen A. Forbes has very aptly pictured the situation in these words.

"The struggle between man and insects began long before the dawn of civilization, has continued without cessation to the present time, and will continue, no doubt, as long as the human race endures. It is due to the fact that both men and certain insect species constantly want the same things at the same time. Its intensity is owing to the vital importance to both, of the things they struggle for, and its long continuance is due to the fact that the contestants are so equally matched. We commonly think of ourselves as the lords and conquerors of nature, but insects had thoroughly mastered the world and taken full possession of it long before man began the attempt. They had, consequently, all the advantage of a possession of the field when the contest began, and they have disputed every step of our invasion of their original domain so persistently and so successfully that we can yet scarcely flatter ourselves that we have gained any very important advantage over them. Here and there a truce has been declared, a treaty made, and even a partnership established . . . . as with the honey bees and silkworms, for example; but wherever their interests and ours are diametrically opposed, the war still goes on and on and neither side can claim a final victory. If they want our crops, they still help themselves to them. If they wish the blood of our domestic animals, they pump it out of the veins of our cattle and our horses at their leisure and under our very eyes. If they choose to take up their abode with us, we cannot even protect our very persons from their annoying and pestiferous attacks. And since the world began we have never yet exterminated—we probably never shall exterminate—so much as a single insect species. They have, in fact, inflicted upon us for ages the most serious evils without our even knowing it. It is the cattle tick which keeps alive and spreads the Texas fever; it is the mosquito which inoculates our blood with yellow fever and malaria; it is the house-fly which carries to our food the germs of typhoid fever; it is the flea of the rat and of other rodents which threatens all America with that dread disease, the bubonic plague—and now that we have begun to discover facts of this order, many other instances of this kind will no doubt presently be brought to light."—Forbes.*

The opinion has prevailed among economic entomologists for many years that insects eat or otherwise destroy, on the average, about ten per cent. of every crop grown in the United States each year. If we strike a balance sheet between man and insects, on this basis, the debit side of the ledger would read something like this:

---

*Forbes, S. A., The Insect, the Farmer, the Teacher, the Citizen, and the State. Illinois State Laboratory of Natural History, 1915.

THE INSECTS OF THE UNITED STATES
in account with
THE AMERICAN PEOPLE

DEBIT
Most Important Items for the Year 1924*

Damage to 2,436,513,000 bushels, corn crop	$240,546,800
Damage to 872,673,000 bushels, wheat crop	113,659,600
Damage to 1,541,900,000 bushels, oats crop	73,949,500
Damage to 292,726,000 bushels, barley, rye, rice crops	24,389,300
Damage to 112,450,000 tons, hay crop	146,764,800
Damage to 977,000 bushels, cloverseed crop	1,336,200
Damage to 105,619,000 bushels, grain sorghums crop	*9,935,300
Damage to 32,001,000 gallons sorghum syrup crop	*2,759,500
Damage to 6,893,000 tons, sugar beet crop	*4,989,000
Damage to 636,462,000 lbs., peanut crop	*4,307,800
Damage to 4,476,000 tons, cottonseed crop	*20,553,800
Damage to 10,081,000 bales, cotton crop	*156,334,700
Damage to 1,474,786,000 lbs., tobacco crop	*29,893,600
Total estimated damage to staple crops by insects	$829,419,900
Damage to 454,784,000 bushels, potato crop	$29,486,100
Damage to 71,861,000 bushels, sweet potato crop	9,229,000
Damage to 15,740,000 bushels, bean crop	*5,748,000
Damage to 7,288,000 bushels, pea crop	*3,678,900
Damage to 16,318,000 bushels, onion crop	*2,201,100
Damage to 740,000 tons, cabbage crop	*1,718,300
Damage to 18,845,000 bushels, vegetable seeds crop	*2,500,000
Damage to sweet corn, tomatoes, melons, cucumbers, asparagus, hops, and other truck crops	*10,000,000
Total estimated damage to vegetable crops by insects	$64,894,000
Damage to 179,443,000 bushels, apple crop	$21,219,300
Damage to 51,679,000 bushels, peach crop	6,591,400
Damage to 17,961,000 bushels, pear crop	2,528,700
Damage to 16,500,000 boxes, orange crop	*8,415,000
Damage to 8,000,000 boxes other citrus fruits	*3,750,000
Total estimated damage to fruit crops by insects	$42,504,400
Damage to 61,892,000 flowers and flowering plants	$6,189,200
Damage to 15,487,000 vegetables and vegetable plants grown under glass	1,548,000
Total estimated damage to nursery and greenhouse products	$7,737,200
Injury to 18,263,000 head of horses	$11,762,000
Injury to 5,436,000 head of mules	4,576,000
Injury to 66,801,000 head of milk cows and cattle	106,452,000
Injury to 38,361,000 head of sheep	3,020,000
Injury to 65,301,000 head of hogs	6,371,000
Injury to 654,200,000 head of chickens	*8,208,000
Total estimated loss in live-stock production by insects	$140,389,000
Total estimated damage to all products in storage	*$300,000,000
Total estimated damage to forest trees and forest products	*$130,000,000
Injury by transmission of malaria by mosquitoes	$50,000,000
Injury by transmission of typhoid fever, tuberculosis, enteritis, diarrhea, etc., by house flies	*25,000,000
Injury by transmission of spotted fever by the tick	*100,000
Total economic loss by insects that carry human diseases	*$75,100,000
Grand Total	$1,590,044,500

*In the case of the items starred (*), estimates are for the latest year available, mostly for 1923.

Such are the considerations that have forced entomologists to conclude that unless insects are more efficiently controlled in the future than they are at present, they may eventually assume proportions that will actually threaten the existence of the human race. We see from the above table, for example, that we had in the United States in 1924 a nearly 2,500,000,000 bushel corn crop, more than four-fifths of a billion bushels of wheat, a billion and a half bushel crop of oats and nearly a third of a billion bushels of other cereals. But while growing this enormous crop we had to yield to the hungry insect pests of cereal crops a toll worth nearly $450,000,000. And this was true not only of cereal crops. The gardeners and truck farmers of America fed another group of hungry bugs, more than $60,000,000 worth of vegetables. As carefully as we guard our fruit crops by spraying and dusting, fruit insects despoiled $40,000,000 worth of apples, peaches, pears, and citrus fruits. And so also for the hay crop and the sugar crop and the cotton crop and the tobacco crop and crops grown under glass—in every case the insects take their share first and man gets what he can save from them.

Farm animals are injured and their yield of products, such as milk, butter, meat, wool, hides, honey, wax, etc., depreciated to an extent estimated at $140,000,000. After man has harvested his share, other insects break into his storehouses and steal a living that costs us all a total of $300,000,000. From disease-carrying insects even sanitary America still suffers grievously, from the illness and death of productive workers; from doctors' bills and hospital bills and druggists' bills; and from the depreciation of land values in places where disease infested insects are abundant, such as farms in malarial districts or summer resorts where mosquitoes or black flies abound.

The principal ways in which these pests attack, annoy and injure us, I have tried to show in this summary of:

Methods of Injury by Insects

A. They destroy our growing crops:
- By eating them.
- By laying eggs in them.
- By using parts of them to build nests or shelters.
- By carrying to them the organisms of plant diseases.

B. They injure our domestic animals:
- By flying or crawling about the body.
- By entering eyes, ears, nostrils.
- By repulsive odours and bad tastes.
- By being accidentally ingested.
- By attempting to lay eggs upon the body.
- By pinching, biting, stinging, or nettling with their venoms.
- By living as parasites habitually on or in the body.
- By sucking the blood for food.
- By carrying to the body the pathogens of animal diseases.

C. They attack the body of man himself:
- In all of the ways named under B.

D. They destroy our stored products and possessions.
- By devouring our meats, fats, cheese, grains, flour, nuts, confections, fruits, vegetables, drugs, and tobacco as food for themselves.
- By consuming woollens, furs, paper, books, labels, photographs, museum specimens, furniture, and buildings.
- By contaminating these and other products with their eggs, their secretions and their excretions.

Why Insects are so Injurious

What are the things that make it possible for insects to carry on such a formidable offensive against man, and the rest of the organic world? They seem to me to be these five.

(1) *Their unprecedented numbers.* The class Insecta is the largest natural group of animals on the globe. It is our belief that one million kinds of insects probably maintain an existence year after year on this continent alone. But laying aside all speculation, we know that more than 400,000 kinds have been scientifically named and described.

What this means may be better appreciated by comparison with some other kinds of animals, probably more familiar to us. A careful count shows that insects are about:

100 times as numerous as mammals,
30 times as numerous as birds or fishes, nearly
100 times as numerous as the worms or reptiles,
45 times as numerous as protozoa, and more than twice as numerous as all other kinds put together.

If we consider numbers of individuals instead of numbers of *kinds*, insects will still dominate the land animals of the world. We calculate that for each man, woman, and child that now treads the earth, there are at least 1,000,000 insects. I believe that it is safe to say that there are more insects on an average square mile of American farm than there are people in all of North America. Their great numbers therefore is the first explanation we find of their destructiveness.

(2) *The small average size* of insects, instead of being a disadvantage, enables them to fit into cracks and crannies of the plant and animal communities where competition is less keen than that among the larger animals. Many insects are so small that dozens of them could find standing room on the head of an ordinary pin. Often hundreds are found feeding on a single leaf. In a practical way we find that this often enables insects to gain a foothold, or become established, in field, orchard, or garden before they are even seen, much less recognized as enemies. They have adapted themselves to a world already crowded with animals, in much the same way that we might pour many grains of wheat into a bushel already filled with apples or potatoes.

(3) If we cut into the body of an insect we do not find any bones. Nervous system, digestive system, excretory organs and muscles we find, but nowhere any trace of bones. Their skin is their skeleton. It is on the *outside* of their delicate tissues instead of covered by them. This skeleton is both very light and very strong, composed of a remarkable substance known as chitin, that is extremely resistant to all ordinary chemicals. Strong acids or lyes or caustic oils have no effect on this body at all. Even boiling potassium hydroxide, which would speedily reduce our bodies to soap, does not destroy the skin of the insect.

This chemical-proof armour is built up as a hollow cylinder which is the strongest type of construction with a given amount of material. It presents at every side an arched construction that is proof against injury by falling, and enables the insect to be very active and very reckless in its habits. And finally, this armour occurs on the body in rings with flexible couplings between, so that the insect has achieved the virtues of armour plate without sacrificing activity or freedom of movement. Their cylindrical, chitinous exoskeleton may be accounted a big element in the success of insects.

(4) *The powers of reproduction* and rapidity of multiplication of most insects are astonishing. We may kill ninety-eight per cent. of the present generation and in six months time a new army of equal magnitude has been begotten by the remaining two per cent. that escaped us. This is made possible by both large families and briefness of life cycle. Compared with thirty years

for man, the shortest known life cycles of insects under normal conditions are about ten days. While the extreme fecundity is well illustrated by the queen of the common honey-bee, which can produce 2,000 to 3,000 eggs daily. She may lay "four times her own weight of eggs each day" for weeks in succession.

(5) The fifth characteristic that has made insects successful I believe is what may be called *fixity of purpose.* Any one who recalls trying to sleep on a sunny summer afternoon in a room with a single housefly will have an inkling of what is implied in this point, *fixity of purpose!* That housefly would alight on your nose, and you could not keep him from it. He practises no caution, he knows no fear, he recognizes no reverses. You may occasionally knock him to the far side of the room, but he comes back. Even if it eventually costs him his life, he *will* alight on your nose and you can't scare him away. Your threats and your abuse make no impression upon his boundless impudence, his singleness of purpose, his energetic abandon to what he considers his duty. That housefly is typical of his whole race! Multiply this one insect by millions, make his form as diverse as the herbs of the field and his method of attack as varied as we have shown it to be, and you have a simple, vivid concept of the problem confronting the human race in the so-called insect peril.

What a field for research! What a challenge to man's boasted intelligence and supposed dominion over the earth! Match your wits against the blind unreasoning instinct of a billion tiny chinch bugs, intent on reaching the near-by cornfield, and see if you can keep them out. Dispute, if you will, the right to possession of a seaside summer resort with the cohorts of bloodthirsty mosquitoes. Conquer the heart of Africa from the deadly grip of the tsetse fly and its consort, sleeping sickness. Say to the European corn borer, which at present has not penetrated into the great corn growing States of America, "thou shalt not invade our corn belt and despoil the crops of our smiling prairies." I verily believe that the man who loves a fight can nowhere in the universe find a setting more ideal than that provided by any abundant, destructive and aggressive insect.

Our enemy, then, in this great contest is characterized (*a*) by a *size* so small that they are often encamped in our midst before we see them; (*b*) by *numbers of soldiers* beyond human comprehension; (*c*) by a *coating of armour*, at once light, remarkably strong, flexible and acid proof; (*d*) by *powers of reproduction* that lead us often to despair of ever reducing their numbers; and (*e*) by a *fearlessness*, an *impudence*, an *absolute abandon* to the dual purpose of finding food for themselves and assuring the security of the next generation.

What shall we do? Some fundamental, scientific methods of preventing insect breeding and increase must be discovered, if we are going to check their gradual encroachment upon all that is necessary for human life and happiness upon the earth. I have noticed recently that the chemists have perfected an alloy of chronium and iron that bids fair to reduce very greatly the $200,000,000 annual loss by iron rust. I wish to show particularly this evening what entomologists are doing to lighten the losses caused by insects.

What Does Insect Control Include?

The mention of insect control usually calls up visions of spraying, and spray pumps. That is the phase of insect control that the public hears most about. But spraying comprises only about one-tenth of the vast programme of control being waged continuously against insect pests. Historically, mechanical and physical measures were doubtless the first artificial control measures employed

against insects. These consist of destruction by hand, mechanical exclusion, the use of traps, drainage, flooding, heat, cold, etc.; any mechanism or operation with which the insect is killed by the physical or mechanical action of the control measure. These are outlined in the following table:

Mechanical or Physical Measures Used for the Control of Insects

1. *Destruction by Hand:* Collecting, crushing or dislodging the insect from plant or animal by human labour.

a. Hand-picking.
b. Jarring off plants; taking advantage of the death-feigning instinct.
c. Swatting.
d. Worming of trees for borers.
e. Scraping of bark under which insects have taken shelter.
f. Pruning infested twigs and burning them.

2. *Mechanical Exclusion:* The interposition of some impassable obstruction between the insect and the object to be protected.

a. Screening of houses, storerooms, restaurants, delivery trucks, exposed foods, beds, persons, individual plants, seed beds.
b. Linear barriers about fields; such as dust furrows, open ditches, straw or fabric or salt saturated with kerosene, fences of cloth or upright sheets of metal.
c. Tree banding, collars, paper discs, etc., for individual plants.
d. Bagging of fruits or fruit clusters.
e. Fly-nets, screen muzzles, nose fringes, etc., to protect animals.

3. *Crushing Machines:* Such as brush drags, rollers, etc.

4. *Traps:* Any device in which an insect is caught and killed or held until it may be destroyed.

a. Mechanical stationary traps; such as deep, smooth holes in the soil; flat stones, boards, heaps of refuse, etc., so placed that the insects congregate under them; the use of loose fabrics in which the insects become entangled; tanglefoot and other adhesive materials; the maggot trap; the codling moth band trap; light traps; window traps, etc.
b. Mechanical moving traps, such as sticky shields, boxes, and wands moved over or among plants or other infested objects to catch the insects that jump or fly from them; hopper-dozers, aphidozers, hopper catchers; vacuum cleaners and other suction traps.
c. Baited traps, in which some odorous material is used to entice the insect, such as fly-traps, roach traps, moth traps.
d. Animals as traps; allowing attractive animals to range over infested buildings or fields in order to concentrate upon them parasites or household insects.
e. Plants as traps, such as sundew, Venus' fly-trap, pitcher plants, bladderworts, milk-weed, etc., in which the plant is naturally adapted to destroy insects. Not utilized by man.

5. *Drainage, Dehydration of Breeding Places:*

a. Drainage of swamps and other breeding places of mosquitoes, horseflies, and other aquatic insects.
b. Scattering of manure promptly and thinly over fields to destroy houseflies.

6. *Flooding and Syringing:*

a. Syringing greenhouse and other plants, for red spider, etc.
b. Flooding lowlands and irrigated districts to destroy cranberry insects, grape phylloxera, and others.

7. *The Use of Heat:*

a. The superheating of mills, dwellings, etc.
b. Burning over fields, fencerows, ditch banks; or burning crop remnants, pruned twigs, wheat straw, branches bearing caterpillar nests, etc., or the use of blast torches and "liquid fire" against insects or their eggs.

8. *The Use of Cold:*

a. Cold storage stops feeding and development and so prevents damage from clothes moths, stored-grain pests, and others.
b. Exposing mills and storerooms to the low temperatures of winter weather may be used to rid them of pests.

9. *The Use of Electricity, Roentgen Rays, etc.* This is still in the experimental stage, although some elaborate machines are in use to destroy the insects in stored products by this means.

Simple methods of retaliation by hand must have been used against annoying biting insects from the very dawn of human evolution, and for some pests,

destruction by hand is still the best method of control. Some clever barriers have been devised to use against insects. Tanglefoot bands to prevent leaf-eating caterpillars from ascending trees. Barrier muzzles to keep flies from laying eggs on our domestic animals. Collars, paper discs and screens of various kinds for individual plants. But nothing illustrates better the persistence and determination of insects than the relatively low efficiency of these mechanical barriers. Take ordinary household screening. Try our best, we never reach perfection in this seemingly simple undertaking. I have known no house, however carefully screened, that remained entirely free from houseflies during even a single week's use.

Linear barriers are much used against such insects as advance to the attack on foot, like army worms and chinch bugs. However carefully constructed and maintained, you may count upon the resourcefulness or persistence of insects to get *some* of their number across the line.

Insect Traps

The animal trapper matches his wits against the cunning of his prey. But insects often have no cunning; and insect traps are, as a rule, unbelievably simple. One of the saving facts in the fight against insects is their almost total lack of intelligence, or the ability to profit by experience, or to reason. They are creatures of instinct which must follow the stimulus from any combination of intrinsic and extrinsic factors in the same way, time after time in the life of the same individual, and generation after generation of the same species much as any engine would follow the same track of iron rails. They are automatons, that do everything in the same way their ancestors did for millions of generations back. On this account, in economic entomology we can deal with the *species as our unit*, instead of the countless *individuals* as would be necessary did they possess the intelligence of the human kind.

The task of the insect trapper then is to discover some characteristic behaviour on the part of the pest under investigation. Being able to depend upon this lack of individuality and absence of reasoning power we can make use of some devices of great simplicity. Having devised some mechanism that will intercept and thwart this characteristic behaviour and enmesh or otherwise destroy the insect, we can count upon practically all individuals following the course that our observations have shown to be typical or instinctive for that species.

Flies at a window, or after having fed, crawl upward, repeatedly upward, and will follow in great numbers into a trap properly constructed and placed in a stable window. Bushels of them crawl upward and inward, but probably not one in a bushel ever crawls downward and outward through the small aperature by which it readily entered.

Roaches may be enticed by bait into a simple Erlenmeyer flask trap until it is crowded with them, but probably not one in a thousand ever finds its way out. Many more-complicated traps have also been devised, as various catchers for grasshoppers, for cotton moths, or for cucumber beetles.

One of the cleverest of insect traps is the so-called "Maggot Trap" devised by Hutchison for the destruction of housefly larvae. Its essential features are a slatted platform about 10′ x 20′ supported above a shallow cement basin with an adjoining pump and tank. Onto this platform are wheeled each day the accumulation of manure from the horse stable; flies develop in this material from the eggs to fully-sized larvae. At this point a critical observation comes into service.

All of us who ever found houseflies in their several stages had a chance to

observe that eggs and maggots are in the moist material, but the pupa stage always in driest portions of the medium. It remained, however, for Hutchison to see the significance of this observation and to bring out the fact that the larva when full grown and ready to pupate has a reversion of tropisms (a negative hydrotaxis) causing it to get away at all cost from wet places before the change takes place to the helpless pupa which would be drowned in water.

All that is necessary, therefore, is to keep the mass of material wet by pumping the drippings back through it once a day, and the larvae, trying to desert the moist habitat, drop through into the tank below and are drowned. One trap collected 110,000 larvae in the two months it was in operation under normal farm conditions. I mention it, because it seems to me to illustrate that point of cleverly taking advantage of observations made under natural conditions, and to emphasize the necessity for *living with* these insect enemies until we can come to think in insect language and interpret every little instinctive movement that is common to all individuals of the species.

Control by Variations in Temperature

One of the noteworthy advances of the last decade was the application of heat to the control of mill insects. Of course it was obvious that any insect could be killed by applying *sufficient* heat, but I think we were all surprised when a careful investigation showed that all of our pests of stored grains and the household could be killed at temperatures within the limits of safety from fires and without injury to the building or its products. In general it may be said that all of our insect pests of stored products are killed by temperatures between 48 degrees and 55 degrees centigrade (120 to 135 degrees Fahrenheit) continued from ten to thirty minutes. Special steam-heating equipment has been installed in hundreds of mills throughout the Middle West as the most practical and efficient method at present known of controlling, completely, all kinds of mill-infesting insects regardless of the life stage or inaccessibility. It is not at all dangerous to human life and there is only slight danger of fire. It is positive in penetration to the interior of the largest bins, given sufficient time.

It kills especially surely the egg stage, which is very resistant to fumigation, and has usually made it necessary to repeat a fumigation after about two weeks. One treatment a year is sufficient with heat, and after the initial installation it costs only one-fifth as much to make an application of heat as it does to fumigate.

We can also use subnormal temperatures, or cold, very successfully for certain pests. In the larger cities the department stores accept winter clothing such as furs and woollens for storage during the summer at temperatures slightly freezing; at which temperature the clothes moths and carpet beetles are incapable of moving or feeding to destroy the clothing.

The Use of Insecticides

Chemical warfare against insects began about fifty years before it was used in human warfare. The modern application of chemicals to plants to destroy their insect parasites began here in the Western Hemisphere sometime between 1860-1867 when someone, whose name has unfortunately been lost to us, dusted his potato vines with Paris green for the first time to check the destructive work of the Colorado potato beetle.

General adoption of this method of control was very slow, partly because of fear of poisoning the tubers, partly because the dust applied burned the leaves badly, and partly because there was no suitable machinery for making

the application. The pioneer entomologist, C. V. Riley, soon grasped the idea that if Paris green would control the potato beetle, it ought also to be effective against other kinds of insects that feed in a similar way. So it was tried against the cotton caterpillar (1872), cankerworms (1873), codling moth (1879) and by the early 80's this material had come into fairly general use.

Paris green has little merit as an insecticide except that it *does* contain arsenic and *will* kill insects that devour it. Yet it remained practically the only insecticide in common use up until 1892 when the necessity for a better poison spray (one that was more highly insoluble and would not burn the foliage) to control the gipsy moth in New England led to the trial and adoption of arsenate of lead which then gradually supplanted Paris green. The rising cost and scarcity of arsenate of lead during the war led to improved methods of manufacture of calcium arsenate. This material is more toxic than arsenate of lead, and is now in the ascendancy. It promises to be the weapon of chief dependency in the fight against the cotton boll weevil in the southern States; 31,000,000 pounds of calcium arsenate, 11,000,000 pounds of lead arsenate, and about 3,000,000 pounds of Paris green were used in 1923. A consumption of over *22,000 tons* of arsenicals in the fight against the insects in this one country alone, which gives us some idea of what a stupendous and costly fight it is.

Insecticides may be considered as of five or six principal groups according to their effect upon the insect and the way in which they are applied.

Some of the More Important Insecticides or Chemicals Used to Control Insects

1. *Stomach Poisons:* Chemicals applied to plants as sprays or dusts. When swallowed by the insect, along with his usual food, they are dissolved in the stomach and cause death.

a. Arsenate of lead, $Pb_3(AsO_4)$ or $PbHAsO_4$.
b. Arsenate of calcium, $Ca_3(AsO_4)_2$.
c. Paris green, $3Cu(AsO_2)_2\ Cu(C_2H_3O_2)_2$.
d. London purple, an impure arsenite of calcium.
e. Arsenic trioxide, As_2O_3.
f. Sodium fluoride, NaF.
g. Hellebore, the powdered roots of the plant *Veratrum album.*

2. *Poisoned Baits:* One of the stronger stomach poisons, mixed with a substance that is very attractive to insects; if possible, more so than their usual food.

3. *Contact Insecticides:* Chemicals applied to insects as sprays or dusts. When they strike the body of the insect, they may (*a*) enter the spiracles, penetrate the tracheae and poison the tissues beyond, or (*b*) clog up the spiracles or otherwise deprive the insect of oxygen and suffocate it, or (*c*) corrode the tissues of the insect directly through the body wall, or (*d*) loosen the insect from the plant, or (*e*) stick the insect fast to the plant, or in some other way accomplish its destruction without requiring to be swallowed.

a. Nicotine and nicotine sulphate.
b. Lime-sulphur, $CaS_5+CaS_4+CaS_2O_3+CaSO_3$.
c. Oil emulsions.
d. Pyrethrum, the powdered blossoms of *Chrysanthemum coccineum.*

4. *Fumigants or Gases:* Chemicals that attack the insect in the gaseous state. Usually applied in an enclosed space of some kind. They may poison the insect through its tracheal system or, by combining with the oxygen of the air about the insect, suffocate it.

a. Hydrocyanic acid gas, HCN.
b. Carbon disulphide, CS_2.
c. Nicotine.
d. Sulphur dioxide, SO_2.
e. Paradichlorobenzene, $C_6H_4Cl_2$.

5. *Repellents:* Chemicals applied to plants, animals or their surroundings, which keep insects from damaging them because of their offensiveness.

a. Bordeaux Mixture.
b. Creosote.
c. Naphthalene.
d. Oil of citronella.

6. *Parasiticides:* Chemicals applied to the bodies of animals to kill their parasites. They may be either stomach poisons or gases, but they are mostly contact insecticides.

a. Nicotine sulphate.
b. Lime-sulphur.
c. Creoline.
d. Raw linseed oil.
e. Mercurial ointment.
f. Sulphur ointment.
g. Sodium fluoride.
h. Pyrethrum.
i. Iodoform.
j. Carbon disulphide.

Considering the many poisonous substances known to the pharmacist, the above menu for insects seems pitiably meagre. It is noteworthy that practically all of the stomach poisons used as sprays for plants are compounds of arsenic. These alone of the substances tried meet the rigorous tests of non-toxicity to the plant, palatability to the insect, adhesiveness, spreading qualities and low cost. The margin between chemicals or dosages that will kill the insect and those that will kill the plant is so slight in all these cases that the materials must be manufactured, compounded and applied with the greatest care.

Certainly among all the compounds known to the chemists, there must be many others that we ought to be using against insect pects. The chemist and the entomologist must co-operate. Or we must greatly extend the period of training of the entomological-chemist or chemical-entomologist, until he has not only mastered entomological principles but has also learned to know the field of chemistry.

In our search for insecticides we must not be limited by the known effect of chemical substances on human beings, rats or guinea pigs. "Trying it on the dog" is not a sufficient or reliable guide to its effect on insects. For certain insects may thrive on a diet of substances that would prove fatal to us; and other substances, not or only mildly toxic to man, are highly so to insects. For example, Forel found that ants ate quantities of honey containing arsenic acid without a one of them showing any signs of suffering. He also introduced strychnine into wounds in their bodies without producing the cramps characteristic of its effects on man.

Quite empirically the substance known as sodium fluoride was discovered about ten years ago to possess remarkably valuable properties for the destruction of lice on poultry, roaches in dwellings, etc.; and paradichlorobenzene as a specific remedy for peach borer has completely revolutionized the control of this pest. It seems almost certain that a number of other common chemicals must possess equally valuable merits, and only await discovery.

The Application of Insecticides

More impressive than the list of spraying materials has been the evolution of the bewildering array of apparatus for applying these materials to the plant. We have already noted how the early adoption of Paris green was greatly delayed by lack of adequate machinery (or indeed *any* machinery) for its application. As recently as 1865 we note the serious recommendation of kerosene to control scale insects on orange trees; the method of application being to pour oil out into a saucer and apply it with a feather! Following this came the whisk broom, used as recently as 1862 in France, the sprinkling can, and the syringe.

A recent writer states that a spraying machine built ten years ago compared with the latest model would exhibit more numerous and impressive improvements than a similar comparison of automobiles.

Various kinds of power have been utilized:

(*a*) That of the human arm as in small atomizers, or bucket pumps, or barrel pumps, or horizontal lever pumps.
(*b*) That of compressed air or other gases.
(*c*) The traction of wheelbarrow or horsedrawn vehicles.
(*d*) And especially the power from a gasoline engine.

It is difficult machinery to design and construct. We require an apparatus that will deposit over the entire exposed parts of plants and trees, on all surfaces, above and below and around, an extremely fine film of liquid with a theoretically

absolute uniformity and with great force or pressure. The apparatus must be designed to provide a powerful pump that is easily portable over rough ground and adaptable to treating tall trees, low bushes, row crops and vines. The engines must have a high ratio of horsepower to weight. Materials must be used for the working parts of the pump that are resistant to the corrosive action of the caustic or gritty or oily chemicals used.

The nozzles which break the liquid into a fine mist have presented a great problem in applied physics. The requisite points that must be met are a solid cone of mist, of great fineness, absolutely uniform density, and great carrying power, and the fragmentation of the liquid without great loss of pressure. The first spray nozzle was invented in 1858, the Bordeaux in 1878; the Vermorel type in 1884, and the disk nozzle in 1906. All of these have taken on a great variety of forms.

One of the most significant improvements was made in 1916 when the scarcity of labour and the almost prohibitive cost of spraying led to the development of the spray gun. This invention has made possible the very rapid covering of trees, with an important saving of labour albeit some waste of materials. In orchard spraying and particularly in spraying forest trees the biggest task has been to reach the higher parts of the trees with a uniform application. In the early days of gipsy moth work in New England, we see men trying to spray tall trees by climbing up into them. The spray gun and a greatly improved type of solid stream nozzle have made it possible to reach the tops of the tallest trees from the ground. So finely adjusted is this apparatus that the distribution of the spray is remarkably uniform and covers the foliage so intimately that scarcely a part of any leaf can be consumed by insect pests without ingesting also some of the poison.

Dusting vs. Spraying

Anyone who has any considerable amount of spraying need not be told that it is a disagreeable job. It is not at all surprising, therefore, that many attempts have been made to substitute dry applications for sprays. In this connection, we must bear in mind that dusting was the original method, historically. Our first stomach poison, Paris green, was at first applied as a dust. There has been a great revival of interest in dusting, especially since about 1900, with the accompanying development of dusting machinery to a very high degree of efficiency.

Dusting is easier, more rapid, and more pleasant work than spraying. Both materials and equipment are much lighter, two pounds of dust having the same covering as ten gallons of spray, weighing eighty pounds. The equipment weighs on the average one-third or one-fourth as much as a sprayer of equal capacity.

The dust materials are generally more expensive, but the saving in labour and equipment will usually offset that. The present consensus of opinion, however, is that, on the whole, dusting is less effective than spraying, except for leaf-eating insects.

Dusting from the Airplane

In 1921, the first use of the airplane in applying insecticides was made in Ohio. The plane was a Curtis, equipped with a special hopper for distributing the dry powered arsenate of lead in measured quantities, into the powerful air current from the propeller of the plane. In this test a six-acre catalpa grove was dusted to destroy the catalpa sphinx.

The plane flew at a speed of eighty miles an hour at a height of twenty to thirty-five feet, passed the grove six times, distributed 175 pounds of poison with remarkable uniformity to every tree, *in an actual dusting time of fifty-four seconds*!

The next summer the U.S. Bureau of Entomology used two planes in an effort to determine the practicability of the airplane in dusting for the control of the cotton boll weevil. Owing to the fact that the air surrounding a moving plane has a strong downward course the dust released from the hopper is immediately converted into a great hollow spiral cloud and forced downward among the plants in spite of strong air currents, with only a very slight amount going off into the air above. Calcium arsenate was laid down in strips of 150 to 200 feet wide, using only two to four pounds of poison to the acre. One machine covered from 240 to 500 acres of cotton an hour, without any more indiscriminate poisoning of adjoining cabins and surrounding pasture lands than results from ground dusting, and at a cost calculated to be less than with other methods.

What the future of spraying and dusting shall be, no one can tell. Two extremes of opinion are:

(1) That we must look forward to the gradual adoption of a complete spraying programme for all crops that we try to grow. That we shall in future not wait until insects and diseases appear in our crops and then spray, but that we shall expect to spray or dust by the calendar or in synchrony with the development of the crop just as we now cultivate and harvest the crop. That is one belief; the other school believes:

(2) That spraying and dusting cannot be expected to permanently solve our insect troubles. That they are but transient expedients to serve us until such time as we can perfect more fundamental methods of dealing with these scourges. That the adoption of elaborate, complete spraying schedules for all crops must break down of its own financial weight. That eventually we shall have preventive control, instead of regaling our plants with drugs after the damage has begun.

The Use of Poisoned Baits

A method of applying stomach poisons that appears to me to promise much for the future, is in so-called "*Poisoned Baits*." Its success depends on finding some substance that is chaemotaxically attractive to the insect, if possible more so than its normal food. This substance is then mixed with a very toxic substance and exposed where the insect may take it.

It seems certain that there must be, in every plant, some chemical constituent that determines that a given insect shall feed on that and no other kind. If we can determine what that attractive substance is, we should be able to mix it with poison and kill thousands of the unsuspecting insects. Besides baiting the feeding stage of an insect, it seems distinctly possible that we can attract with a proper bait the ovipositing females which must in many cases find the proper host plant or other media for their young by chaemotaxis. The reason this method seems to me to promise so much is that once we have determined and isolated the stimulating substance in any given case, we have in our hands the power to vary its strength and we should be able to make it sufficiently more attractive than the normal natural food that we could collect and destroy an appreciable percentage of the individuals in a given section.

The most widely used of poison baits have been the various mixtures of bran, arsenic, water, molasses and other attractive substances such as fruit-

juices, commonly known as poisoned bran mash. First brought to light about 1865 it was not used in a big way until about 1912. During the last decade this has developed into a sovereign remedy for cut-worms, army worms, and especially for grasshoppers. In 1919, thirty-nine counties in Kansas used 4,565 tons or 183 carloads of bran, eighty-three tons of white arsenic, 83,000 gallons of molasses and 498,000 lemons to make grasshopper bait. In 1920 the Dominion Entomologist directed the treatment of over 1,400,000 acres of wheat in Saskatchewan, with the saving of $20,000,000 worth of grain otherwise doomed to destruction. In Montana in 1922, over 5,500 tons of poisoned bran mash were used in combating the plague of grasshoppers.

In 1922 two Canadian entomologists reported upon a method of using liquid poisoned baits for cut-worm moths that challenges one's admiration. They used a mixture of soluble arsenic in water with some saccharine and amyl acetate. The odorous amyl acetate attracted the moths even away from flowers of goldenrod and Russian thistle upon which they normally feed. They fed upon it freely, but did not die from its effects for from eight to forty hours. During this interval they flew away from the trap and many of the females would lay their eggs before they could be killed by the poison, thus defeating the purpose of the trap. These ingenious Canadians discovered that by adding a trace of quassia to the liquid bait that the quassia paralyzed the moths and prevented them from laying their eggs until the arsenic had had time to kill them.

Their method of exposing the bait was as interesting as the bait itself. Since one bait trap must be exposed about every ten rods about the field, the method would be impractical unless it were practically a self-feeder. The moths begin flying at dusk and the bait should be exposed each day shortly before this time, but it would involve too much labour to set the trap daily. To accomplish this purpose they used a bottle (such as a beer bottle) fitting it with a six-inch lamp wick held in place by a cork. The filled bottles were inverted and wired to the *west* side of fence-posts, tree-trunks, etc., where the sun would strike them only in the late afternoon. The heat of the sun caused the liquid to expand sufficiently to force it out and wet the wick enough to attract the moths all night long. One filling was enough to run the bait trap for ten to fourteen days.

Fumigation for Insects

For the treatment of infested objects that are, or can be, enclosed in an air-tight container, fumigation or the use of poison gases affords a powerful weapon. It has very many applications, such as greenhouse fumigation, mill fumigation, or the treatment of dwellings, storerooms, nursery stock, citrus trees, infested soil, etc. The gas may be generated by the pot-method in which a bag of sodium cyanide is lowered into an earthenware jar of sulphuric acid and water, resulting in the immediate evolution of a great cloud of hydrocyanic acid gas, one of the most toxic substances known.

For nursery stock, seeds, cotton, etc., special fumigating chambers are often used in which the dosage is carefully regulated to kill the insects without injury to the living plants. In California the gas is used to treat the living citrus trees by enveloping them in huge gas-tight bags, and then generating the gas inside the bag. There are many improved methods of generating the gas by means of machines which automatically admit the correct amount of sulphuric acid into a mixture of sodium cyanide and water and conduct the gas so generated to the tent near-by. More recently a liquefied hydrocyanic acid gas is shipped in drums and vaporized as needed by heat supplied by burning the exhaust gas

of the Ford car. In 1915 it was found that by fumigating in a vacuum much better penetration of the gas into the interior of bales of cotton and the like could be procured, thus greatly increasing the usefulness of this method of fighting insect pests.

The Place of Farm Practices in Insect Control

For the protection of mills, storehouses, orchards, gardens, and greenhouse plants we can afford these physical and chemical methods of control. But for the vast acreages of field crops, of relatively low value per acre, we must depend upon less expensive methods, or methods involving no expense at all. Such measures require more careful research, more searching naturalistic observations, a fuller knowledge of the life-history, behaviour, and biology of the insect than any hitherto discussed. But having been once perfected they can be applied at almost no cost.

Here fall such methods as burning chinch bugs in winter quarters, the use of resistant varieties of corn, delayed seeding for Hessian fly and the plowing under of refuse infested with corn borers.

In the farm practices certain entomologists see hope of a more fundamental and permanent scheme of control than that by chemicals, in the belief that once carefully worked out and applied these agronomic measures will create a habitat in which obnoxious insects cannot easily develop to the point where they become a scourge. That will not, however, be achieved in our generation nor the next.

Farm Practices for the Control of Insects

1. *Crop Rotation:*

a. Variety in succession of crops on a given area.
b. Shifting acreage of a given crop to distant fields to compel migration.
c. Rotating animals on pasturage to eliminate parasites.

2. *Variations in Time or Method of Planting or Harvesting:*

a. To avoid egg-laying time of the insect.
b. To get the crop mature before its pests become abundant.
c. To get plants well established before the attack comes.
d. To cut short the development of some stage or generation.
e. Planting a surplus of seeds and thinning.

3. *Stimulating Plant Growth:*

a. By careful preparation of seed bed.
b. By proper drainage and conservation of soil moisture.
c. By timely planting of good seed.
d. By applying carefully selected fertilizers to force infested plants.

4. *Clean Farming:*

a. Destruction of weeds, particularly those closely related to crop being grown.
b. Keeping down volunteer plants.
c. Destruction of crop remnants.
d. Removal, burning or burying of trash or rubbish.
e. Thorough cleaning of storage-houses when emptied.
f. Scraping of bark, whitewashing, etc.

5. *Tillage or Cultural Methods:*

a. Deep plowing in late fall or early spring.
b. Fallowing.
c. Frequent shallow cultivations.

6. *Use of Resistant Varieties:*

a. Varieties of the plant on which the particular insect will not feed.
b. Varieties of the plant which, though attacked by the insect, withstand it and make a crop in spite of it.

7. *Use of Trap Crops:*

a. A small area of the same kind of crop so planted as to be in a particularly attractive stage at the time the attack comes on.
b. A small area of a different crop that is especially attractive to the insect.

8. *Improved Methods of Storage:*
a. Storage in well-built storerooms.
b. Storage in large bulk.
c. Air-tight storage.
d. Screening, covering, sealing, to prevent infestation.

THE UTILIZATION OF THE INSECT ENEMIES OF INSECTS

I wish I had the ability and the time to convey to you a real impression of the complexity of the undertaking of fighting injurious insects with other insects. It is a matter of the commonest observation that some insects eat others, either as *predators*, catching and devouring their prey much as a cat does mice, or as *parasites*, in which case the young, wingless stages of the parasitic insect commonly live and feed as maggots inside the body of the host. I cannot tell you the value of the work performed by predaceous and parasitic insects, but it is generally felt by all who study the matter carefully that, without the work of these friends to agriculture, no farmer could save enough of his crops year after year to make a living. Most of our injurious insects vary greatly in numbers from year to year. We have grasshopper years and chinch bug years and Hessian fly years and army worm years, when these destructive pests descend upon us in countless numbers after perhaps a series of years of comparative immunity. This fluctuation seems to be due principally to two causes. One of them is the weather, the other is the attack by insect parasites and predators. We have not yet learned to influence or control the weather, but it has been found possible artificially to encourage the entomophagous insects, to increase their numbers, to extend their distribution and otherwise enhance their usefulness.

The following methods have been used:

(1) Concentrating them at points where their activities will do the most good. Ladybird beetles are thus collected in waste land, kept in cold storage over winter and liberated in the spring among truck crops where their prey has appeared. The California State Commission of Horticulture collected in 1910 over a ton of the convergent lady-bird beetle about the bases of plants in mountain valleys. These were kept over winter and in the spring boxed in 60,000 separate lots and redistributed to truckers and melon growers to devour the plant lice on their crops.

(2) Besides collecting the predators that have grown naturally out-of-doors, these insects may be cultivated or propagated in tremendous numbers in the laboratory and thus return to the combat in the spring an army whose numbers have been multiplied many times during the winter.

(3) There are many parasites that are not widely distributed that occur and perform their beneficial work only in restricted states, or provinces, or continents. Especially for the recently introduced foreign pests that are brought to our country from the ends of the earth on nursery stock and other importations, we often find in the country from which they came the insect warriors that will enable us to overcome their ravages, but which were left behind when their hosts were imported. Our problem then becomes one of finding out what these parasites are, of assuring ourselves that, if brought in our country, they may not do more harm than good; and, when so assured, of shipping them successfully to America and getting them established in the new environment.

A type of work that promises more and at the same time involves greater difficulties and risks could hardly be imagined. The experience of Australia with her introduced jack rabbits, and that of America with the English sparrow, warns us that we are in great danger of doing vastly more harm than good unless

any importation of foreign species is preceded by *the most searching scrutiny* of its natural habits, and careful experimentation with it, under *varied* conditions, until we can say with assurance what its behaviour will be. It is a source of much comfort that among the hundreds of thousands of such insects that have been brought to America in the last twenty-five years, no blunder like that of the English sparrow or of the jack rabbit introduction has yet been committed by entomologists.

Once reasonably assured that the parasite is a desirable one, the painstaking work of trained operators is required to successfully collect a sufficient number to ship; to hit upon a successful method of packing for shipping. Shall they be sent in the egg stage, or as crawling larvae, in the quiescent pupa stage or as the active adults? If sent as larvae or adults how shall we assure an abundant supply of fresh food of a suitable kind during the long voyage of days or weeks on the ocean? If as dormant eggs or pupae how shall we make sure that they do not hatch or emerge in transit with resultant death from lack of attention?

If coming from a different latitude, when shall we start them to make sure they will arrive, not in the middle of the winter or at a time when the host they attack is not available but at the proper season to begin activities with the most hope of success? Once successfully across the seas, they must be submitted to a second searching test under the new environment and if they possess any traitorous characteristics these must be discovered before they are passed out beyond human control. Then they are ready to be turned out to the great silent battle of bug against bug. So great have been the difficulties, so tremendous the risks involved and so frequent the disappointments that I imagine none would have the courage to undertake this type of biological control were it not that we now have a number of cases of pronounced success to reinforce our courage.

Legislation for Insect Control

The final phase of insect control to which I must refer briefly is control by means of legislation. Most of our worst pests are introduced ones, at least 100 major plant pests having been brought to America from other countries, to say nothing of those of minor importance. There is little chance for an insect pest to spread from one continent to another except as aided by man's commerce, especially the traffic in living plants. If we had had an efficient system of inspection and quarantine in time, we would not now be spending millions of dollars fighting the San Jose Scale, the Cotton Boll Weevil, the Japanese Beetle, the Brown-tail Moth, the Oriental Fruit Moth, and many others. The leading European nations restricted the entry of plants and plant products to their countries more than fifty years ago. But it was not until 1912 that the United States had legal authority to defend its people against the dumping onto our soil of the diseased and defective plant refuse from all other countries. As Forbes has so pertinently said: "Insects are generally less refractory to the control of man than man himself." "It is less difficult to perfect methods of preventing insect damage than it is to induce the threatened victims to make effective use of them." It took four years of effort to get the U.S. Plant Quarantine Act of 1912 enacted into law, because of the opposition to it of plant importers. Dr. C. L. Marlatt has pointed out that during these four years, four insect pests of the gravest nature became established on American soil: The European Corn Borer, The Japanese Beetle, The Oriental Fruit Moth and The Camphor Scale, besides two serious plant diseases—Potato Wart and Citrus Canker.

Six major pests in four years previous to the enactment of the Plant Quaran-

tine Act! In more than ten years since its enactment only one pest, the Pink Boll-worm of cotton has become established and that came in from Mexico before we knew it was present there and before the Mexican border control, which now causes the inspection of all railroad and other traffic from Mexico, was perfected.

About fifteen domestic and twenty-two foreign quarantines are now in force, prohibiting the importation or inter-state movement of nursery stock, trees, cotton, corn, fruits, cereals, potatoes, or other vegetables dangerously likely to bring in or carry plant pests or diseases. This work involves an annual expenditure of more than $2,000,000 by the U.S. government. But during the past ten years it has caused the interception and destruction of many thousands of shipments of destructive pests, including more than 100 new pests that do not now occur in America. Granting that even one of these pests would have become established in the absence of the inspection work, there is no doubt that the work has much more than paid for itself.

This work is accomplished in three principal ways: (*a*) Inspection at the port of entry; (*b*) fumigation of suspected materials; (*c*) quarantines which make it illegal to bring into the country materials dangerously likely to introduce pests. Besides the $2,000,000 spent by the federal government about an equal amount is expended by the several states. The state work is concerned primarily with nursery inspection and certification to see that places where plants are grown for sale shall not be hotbeds for the distribution of all kinds of plant pests, and with the detection and suppression of all kinds of pests wherever found, which by their ravages have approached the point of becoming a public nuisance.

This then is the programme of insect warfare:—

(*a*) The use of chemicals or insecticides.

(*b*) The use of mechanical or physical measures or devices.

(*c*) The use of certain farm practices that check insect multiplication.

(*d*) The encouraging and utilizing of natural enemies.

(*e*) By legislation to control those human practices which endanger our success.

It contains much of which entomologists are justly proud—but at the same time is bristling with suggestions of multitudes of problems as yet unsolved and fields for research as yet untrodden.

In Conclusion

There can scarcely be any doubt that there is a real insect peril; probably more significant to the human race than any possible danger from human hands. Our greatest need is for an awakened public interest in insect control; an informed populace that knows at least the fundamentals of the many methods of fighting insects outlined above. It is believed that enough is known about insects now to prevent half of the injury they do, if farmers and others could be brought to put the known remedies into operation. The other great need is for a vastly greater study of the insects themselves. Only about one-fifth of the kinds of insects that probably inhabit the earth have so much as been named. It is only a mere fraction of them about which we have an adequate idea of their life habits. A much larger body of entomologists is needed to study the habits, the structure, the life-histories and the behaviour of insects; to discover more effective traps and baits; farm practices, sprays, dusts and fumigants; to keep away from our shores the many destructive foreign pests that do not now inhabit this continent; and to study the beneficial insects of the countries of the world, in order that we may make the widest possible use of these tireless and inexpensive allies.

THE SPREAD AND DEGREE OF INFESTATION OF THE EUROPEAN CORN BORER IN 1924

W. N. Keenan, Division of Foreign Pests Suppression, Department of Agriculture, Ottawa

The season of 1924 has proven to be unexpectedly favourable for the development of the European Corn Borer. The spread to new townships on the north and east indicates that the pest is not going to confine itself to troubling growers in the extreme southern portion of the province and emphasizes the necessity for preventive measures in retarding further spread as much as possible. In the majority of the infested areas, the degree of infestation increased considerably this year and in the chief corn growing counties on the west it has increased far beyond all expectations.

The pest is believed to have been established in the St. Thomas district about ten years previous to its discovery in 1920. Scouting carried on that year showed that thirty-five townships were infested, covering an area of 2,780 square miles. In 1921, seventy-one additional townships were added to the quarantine; in 1922, forty-five more were infested and eleven were included in the quarantine on account of their situation. The area under quarantine, as a result of the spread in 1922, comprised practically all territory south of a line drawn from Toronto to Goderich, as well as others north of this in Huron, Perth and Peel counties, all shore townships east of Toronto as far as Clarke and the township of Brighton, Northumberland county. In 1923 only eight additional townships were found infested, four of which were in Bruce and Huron counties, but no collections were taken east of the previous year's discovery in Brighton township. The most northern record that year was taken in the township of Saugeen, Bruce county. The situation, as brought out in the 1923 border scouting, and the fact that the greater portion of the uninfested townships in the counties of Huron, Bruce, Grey, Dufferin and Wellington counties were not important in corn growing, as well as their geographical position, suggested the advisability of concentrating future spread preventive measures on the eastern border, and in April, 1924 the quarantine line was extended to include the above mentioned counties complete, also two border townships in York county and Hope township in Durham county. The total area under quarantine in 1924 comprised 216 townships, covering an area of approximately 17,860 square miles.

This season, 1924, scouting in the border area north of Toronto and all corn growing townships eastward along Lake Ontario and the St. Lawrence River, as far as Cornwall, was again carried on. No new infestations were found in the area north of Toronto but collections were taken in the three western shore townships in Northumberland county and in the townships of Ameliasburg and Hillier in Prince Edward county. On account of the small staff available and the necessity for inspecting the St. Lawrence townships to the east, the remaining townships in Prince Edward county were not examined.

The Division of Field Crop and Garden Insects examined certain portions of the counties of Huron, Bruce, Grey and Wellington, which were uninfested in 1923, with the result that three new townships were found infested in Huron county, five in Bruce county, one in Grey county and two in Wellington county. During this work the most northern record of the pest to date was collected in Arran township, Bruce county.

Degrees of Infestation in Infested Territory

The rapidity with which the corn borer increases under the varied crop conditions occurring throughout all older infested areas first received attention in 1922, when accurate records were taken chiefly in the counties of Elgin and Middlesex; but on account of the advanced season the system adopted for obtaining these records was not suitable for annual comparison purposes. In 1923 a standard and more or less satisfactory system was adopted and definite points for annual record purposes were established. As the 1922 records referred to above, as well as the records obtained by the control investigational staff during the three seasons of 1920, 1921 and 1922 were compiled in an article prepared for this Society last year, it would appear sufficient to review here only the increase in the degree of intensity from the comparisons of systematically obtained records taken in 1923 and 1924. The records procured last year have been of great assistance in bringing about the realization of the prolific nature of the corn borer in areas where the food plant is abundant and control measures unpractised. Records were taken from the same points in the three concentric circles radiating from the original centre of the infestation and at each other permanent point with the exception of one in Perth county. Also, many new observations points have been added to our list this year, records of which, although not accurately comparable with any previous records, are very significant on account of known conditions occurring previously. The following is a summary of the conditions noted during the past two seasons:

Area	Highest per cent. Infestation		Lowest per cent. Infestation		Average per cent. Infestation		Total No. Fields Examined	
	1923	1924	1923	1924	1923	1924	1923	1924
Circle No. 1 (6-8 miles)	68.0	99.0	4.33	4.6	30.16	59.72	55	55
Circle No. 2 (15 miles)	47.0	72.0	0.0	3.6	16.97	32.52	80	80
Circle No. 3 (30 miles)	7.66	28.3	0.0	0.0	1.93	7.72	135	135
Essex County (80-110 miles)	13.66	82.33	0.0	0.7	1.31	13.53	48	85
Haldimand	......	2.6	......	0.01	......	1.14	......	10
Huron (50-70 miles)	1.4	3.0	0.0	0.0	0.3	1.36	12	10
Kent	......	84.3	......	0.3	......	24.19	......	40
Lambton	......	11.3	......	0.1	......	3.21	......	25
Lincoln	0.6	1.6	0.0	0.0	0.2	0.4	15	15
Norfolk, East (45 miles)	1.2	4.6	0.0	0.9	0.32	2.66	5	5
Middlesex (Northwest)	......	13.3	......	0.6	......	6.46	......	10
Oxford (40-45 miles)	2.8	12.6	0.0	0.0	0.93	3.61	15	15
Perth (50-60 miles)	1.3	......	0.1	......	0.57	......	10	......
Welland (95-115 miles)	4.4	11.0	0.0	0.0	1.06	2.92	45	45

Note.—Mileage stated represents the distance from Union village, the original centre of the infestation. Welland county first found infested in 1920, and apparently a separate outbreak.

The above records show an increase at each observation point. For the comparative increase the average per cent. of infestation in each circle and county may be used to advantage; thus we find that the area represented by Circle No. 1 increased at the rate of 100 per cent. in one season; Circle No. 2 increased about 100 per cent.; Circle No. 3 increased 300 per cent. Records in Essex county shows an increase of about 900 per cent., Huron county, 350 per cent., Lincoln county, 100 per cent., Norfolk county, 700 per cent.; Oxford county, 280 per cent.; and Welland county, 170 per cent. In addition the records from Haldimand county undoubtedly represent an increase. This applies also

to northwestern Middlesex and Lambton county although standard records were not obtained there in 1923. Without doubt Kent county has suffered an increase of several hundred per cent. in 1924 over the previous season, but records are not available for comparison.

Although the area covered by Circle No. 1 and situated within districts where control practices have been advised shows an increase of 100 per cent., it should be pointed out that all border territory surrounding the control demonstration area was left practically undisturbed by the growers, which naturally reduced the results of control efforts in this area on account of reinfestation by adult flight. Also, the increase, even indicating the presence of two larvae to one of the previous season, may be very favourably compared with conditions in other sections, on account of the fact that the district has all the essentials for encouraging an increase of the pest and the other favourable districts show an increase ranging from 250 to 900 per cent.

In the territory which has been infested for some seasons the county of Lincoln may be regarded as the least favourable for the development of the corn borer, as the increase there was only one hundred per cent., or two to one, and as far as we are aware, control operations were not practised to any extent. The increase is sufficient, however, to signify the importance of conditions which may be expected within a few years. Welland county has also experienced a considerable increase, although the degree of infestation is still small, considering the number of years it has been infested.

As a summary of the above, it may be stated that lake shore conditions continue to favour both spread and increase, and the degree of infestation throughout naturally coincides with the length of the presence of the pest in a community. Various conditions existing in Essex county, the large corn acreage and the methods of handling the crops naturally afford the most suitable factors for increase, and this year's results show what may be expected if control measures are not adopted on a county wide scale.

The corn canning industry has also experienced greater difficulties this year than ever before. The Aylmer plant is the only one that has been seriously affected as yet, although several others are becoming extremely anxious. A review of the development of the outbreak, since 1920, in areas where corn was obtained for the Aylmer plant, was included in a similar paper presented last year and it will therefore be sufficient at this time to refer to this season's situation only, which may be summarized as follows: Contractors were required to cull as many infested ears as possible in the field. The mechanical huskers at the plant had to be abandoned and an extra staff engaged for hand husking and separating the infested ears from the uninfested. It was then carefully inspected after husking and any infested portions were cut off. Even with field culling approximately 25 per cent. of the corn was refused on arrival at the plant, without unloading.

The officials of the corn canning plants have given their greatest co-operation in bringing about control measures. Many valuable suggestions have been received from them, and both financial and labour assistance have been placed at the disposal of control campaigns.

In 1923, although twelve thousand square miles were infested by the European corn borer, it was only in approximately one thousand square miles that the degree of infestation was of sufficient intensity as to cause serious losses to the corn crop. In 1924 the heavily infested area has increased so that it now covers four thousand square miles. It is impossible to foretell what the ultimate range of the European corn borer on this continent will be, or to what extent it

will continue as a serious pest, but we do know from the experiments which have been carried out on the various experimental farms that corn can be grown as a profitable fodder crop over a much larger area than was previously anticipated. Is it therefore unreasonable to assume, judging from the known European habits of this insect, that its ultimate range may include all those areas in which corn is grown, and if this is the case, should not every precaution be taken to prevent the artificial spread of the insect, by quarantine or other means, into other districts far removed from the known infested area?

MORTALITY OF THE LARVAE OF THE EUROPEAN CORN BORER (*Pyrausta nubilalis* Hubn.) IN THE EARLY INSTARS IN 1924

PROF. L. CAESAR, ONTARIO AGRICULTURAL COLLEGE, GUELPH

When we keep in mind that the females of the European corn borer are capable of laying an average of at least 400 eggs each, almost all of which hatch, and when we know that the mortality of the larvae from the effects of winter, disease and parasites combined is small—not more than about 10 per cent.—we ask ourselves why the increase of the borer has not been even much more rapid than it has been.

One reason is that birds, especially the woodpeckers, in fall, winter and spring remove many borers from the stubble, stalks and weeds left exposed in the fields. Another reason is that ants and other predaceous insects both in fall and spring destroy many borers either in their burrows or when moving around from one plant to another or when, after the corn field has been plowed, they come up to the surface. Another reason, and in most counties a very important one, is that much of the corn crop is either put into the silo or run through the shredder or cutting box or fed whole to live stock and most of the borers present thus destroyed. Moreover, many of the corn fields are plowed either in the fall or spring, thus burying infested stubble and debris and accounting for the death of many borers.

All these things have done much and some of them can be made to do a great deal more in retarding the rate of increase of the insect. But in addition to all of them there is another great factor at work which helps us much more than we had anticipated in preventing the more rapid increase of the insect, namely: the fact that after the larvae hatch from the eggs and while they are still very small a large percentage of them perish. To determine how great this mortality in the early instars of the borer was this year the following experiment was conducted.

PLAN OF THE EXPERIMENT

Two blocks of corn growing side by side were chosen, each block having been planted by ourselves and consisting of about one-quarter acre. The blocks were each divided into three equal portions. In one block one portion had been planted with Golden Bantam corn, another with dent (Wisconsin No. 7) and the other with flint (Longfellow); in the other block one portion had dent (Wisconsin No. 7), another flint (Longfellow) and the other a late, sweet variety (Stowell's Evergreen).

The first block was planted on May 19th and the other two weeks later but owing to the backward spring the late planted one had almost caught up to the other at the time of the experiment and as the results in each block were practically the same no attention need be paid to the difference in time of planting.

On July 29th, eighteen squares consisting of four hills each, that is, three

squares in each of the six subdivisions or portions mentioned above, were chosen for the experiment. All of the hills in these squares at the date just mentioned were free from both eggs and larvae and all eggs laid on them later were removed before they could hatch. Moreover, to prevent larvae from the surrounding corn moving into them all adjacent hills on every side of each square were removed to a distance of seven feet and the outer leaves on the plants just beyond these were pulled off to increase still further the isolation of the squares.

On August 2nd and 4th, when the corn averaged nearly three feet high, 150 eggs were artificially fastened on the under side of the leaves on each hill in each of the squares of the early planted block; and on August 7th and 8th, seventy-five eggs (it was too difficult to secure 150 for this block) were similarly placed on every hill in all the squares in the late planted block.

At the expiration of twelve days from the time the eggs were placed on each square two of the hills in each were pulled, cut up, the larvae counted, removed and preserved in vials. At this date the larvae averaged a little less than one-quarter of an inch in length and varied in age from seven to eleven days. Twelve days later the remaining hills on each square were pulled and the larvae removed and preserved as above. The larvae in this case averaged one-half inch in length, none of them being full grown. They varied in age from nineteen to twenty-three days.

So far as we could determine, all the eggs in the experiment hatched.

Summary of Results

From the hills pulled and examined twelve days after inoculating them with eggs, that is from half the hills of each square in each block, 961 living larvae out of a total possible of 4,050 were recovered or 23.72 per cent., thus showing a mortality of 76.28 per cent. in what was approximately the first two instars, or while the larvae were not more than from seven to eleven days old.

2. From the remaining half of the squares pulled and examined twelve days later, or twenty-four days after inoculation, 845 living larvae were recovered out of a total possible of 4,050, or 20.81 per cent., thus showing a mortality of 79.19 per cent. up to the time when the larvae were from nineteen to twenty-three days old.

From these two results it will be seen that there was a large mortality of the larvae and that nearly all of it—all but 12.91 per cent.—occurred while the larvae were still very small, probably while almost all of them were in the first instar and before they had been able to establish themselves in the plant, at any rate before they were more than one-quarter inch long.

3. The mortality by varieties for both blocks combined was:—

Golden Bantam, 79.1 per cent.
Stowell's Evergreen, 80.92 per cent.
Dent (Wisconsin No. 7), 76.54 per cent.
Flint (Longfellow), 76.66 per cent.

From these figures it will be seen that there was not much difference in the mortality on one variety compared with that on another, though it was a little higher on the two sweet varieties than on either the dent or flint.

4. The average mortality in the earlier inoculated plot compared with the later inoculated one was—early plot, 78.00 per cent.; late plot, 77.49 per cent. Hence there was practically no difference between these. This was to be expected because the interval between the dates of inoculation was short, averaging only four days, and because there was not much variation in the weather conditions.

Data on Mortality Obtained from the Inspection of Very Lightly Infested Fields

In 1923 after inspecting many fields in the county of Norfolk, where there were only a very few borers in any field examined, it occurred to me that it might be possible in future to get some data on the mortality of the larvae from the time of hatching of the eggs up to the time the borers reached maturity by examining in September a considerable number of infested hills and finding the average number of surviving larvae per hill in these isolated cases of infestation; because there is very little doubt that in almost every case the larvae present would have come from a single egg mass. Accordingly in 1924 Mr. J. A. Flock and I, when inspecting the Norfolk county in September, examined carefully twenty-nine such hills in about a dozen fields. The adjacent hills in each case were also examined lest larvae might have migrated to these. Wherever two or more hills together appeared to have had egg masses laid on each of them we did not examine these, because this would have confused the results and led to inaccuracies. The fact however was that there were very few such instances. In the twenty-nine hills examined a total of 133 larvae or an average of 4.66 per hill were recovered. Seven of the hills had from seven to eleven borers, the remainder had from 0 to 6. If we assume that each hill had only one egg mass laid upon it and that the egg masses averaged 15.6 eggs each (which was the average found by Mr. G. J. Spencer this year in a field in Elgin county, after counting fifty-seven masses) this would give us approximately 30 per cent. of surviving larvae or a mortality of 70 per cent. It is quite probable, however, that on one or two of the hills there may have been two egg masses instead of one or that 15.6 was rather too low an average for the number of eggs per mass for these fields, so if we suppose the average to have been eighteen eggs per mass, which would probably be more nearly correct, this would give us a mortality of 74.12 per cent., which is about 3 per cent. lower than the mortality obtained in the previous experiment.

General Remarks

The above results and also the results of somewhat similar experiments conducted by other investigators both in Canada and the United States show that there was this year a large mortality of the larvae up to the time of their maturity. All agree that this mortality took place almost entirely in the early instars. The causes, however, have not been fully worked out. We know that a heavy rain will wash recently hatched larvae off the plants and that most of them will not get back. Heavy winds will do the same. Mr. Spencer has observed recently hatched larvae remain on the leaves and die from no visible cause. It is probable that the number of young larvae which perishes one year will sometimes be much greater than that which perishes another and that the difference will be found to be due to the difference in weather conditions—temperature, moisture and sunlight—one year compared with another. We know that insects are remarkably sensitive to these factors and I cannot help hoping that in a normal season the mortality of the larvae would have been much greater than it was this season; and also that the weather conditions this year by being more favourable either to the larvae or to the moths themselves by causing the latter to live longer and lay more eggs or by being favourable to both larvae and moths accounted for a good deal of the enormous increase which the borer made in Ontario in 1924. If I am correct a study of the effect of variations of temperature, moisture and light upon both the adults and larvae will give some very valuable data which will help us greatly to determine what to expect under different climatic conditions wherever corn may be grown.

A FIELD STUDY OF THE REDUCTION OF EUROPEAN CORN BORER LARVAE IN STANDING CORN

R. H. PAINTER AND G. A. FICHT, ENTOMOLOGICAL BRANCH, OTTAWA

In order to obtain some definite information on the seasonal mortality of the larvae of the European Corn Borer (*Pyrausta nubilalis* Hubn.) the following work was carried on at Port Stanley throughout the season of 1924.

So as to make this paper more comprehensible, a general idea of the methods used in the studies should be given. Blocks of corn in three fields—one of each type, dent, flint and sweet corn, were staked off and within these blocks larval counts were made. These counts were taken upon twenty-five stalks made every three days, starting from the time the first eggs were found in the field and continuing up to the middle of November. These stalks were carefully worked over and the live and dead larvae recorded. It must be remembered that these stalks had not been artificially infested, and that the larvae recovered are those which had started the season from eggs laid on the plants under normal field conditions. In order to have some estimate of the number of larvae to expect per plant, egg-laying observations were made throughout the entire period of oviposition on fifty plants of each type of corn, twenty-five at each end of the blocks from which the stalks were cut. The eggs recovered from these check stalks were averaged and serve as the number to be expected on the stalks within the block.

In the late season there is a certain amount of migration in the field, but as the blocks from which these counts were made were in the centre of the field, this migration would be of little significance as the movement would be expected to be equal in all directions.

For the sake of brevity the field studies have been grouped under four headings, each, in general, representing a period in the development of the larvae in the field. These headings are as follows:—

1. Mortality during the time of oviposition when only small larvae are encountered.
2. Mortality after the time of oviposition but when the majority of the larvae are still small.
3. Mortality when practically all the larvae have become established.
4. Mortality when all the larvae have become full grown.

It is during the first period when the larvae are all very small that we have the highest death rate. This occurs during the period when they are attempting to establish themselves. This period is of great importance. The young larvae on hatching make their way into the curled leaves in the throat of the plant and many are drowned in the water which collects there. Observations have shown that the young larvae are quite helpless when surrounded by a film of water. Another way in which they appear to be killed is by being pinched between the surfaces of unfolding leaves, as many flattened ones were found between the leaves in the throat of the plants examined. The mortality among those recovered for this period is as follows: In dent, 18.22 per cent., flint, 25.8 per cent., and sweet, 10.25 per cent.

During the second period the mortality is only about one-half that of the former, being, in dent, 8.36 per cent., flint, 16.89 per cent., and in sweet, 5.64 per cent., thus showing that as the numbers of small larvae, first instar especially, became less, there is a marked decrease in the death rate. It would seem that

the critical period in the life of the larvae is during the first and second instar, as analysis of the dead ones recovered shows them to be practically all in these two stages.

It must not be taken for granted that these figures represent the total mortality for the period. On comparing the number expected from the egg-laying studies with those actually recovered, it was found that there was a large percentage of those starting which could not be accurately accounted for. Some idea of this loss may be gathered from the following figures. In the dent corn, of the expected number only 13.34 per cent. had been recovered, in the flint, 19.10 per cent., and in the sweet, 27.93 per cent. The explanation offered as to what became of these larvae is that in all probability shortly after hatching, and before they had reached the throat of the plant, and while they were still on the exposed surface of the leaves, they were either blown or brushed off and perished on the ground, being too small to travel in loose soil. Thus we have in the first instar estimated reduction from this source of, in dent, 86.66 per cent.; flint, 80.90 per cent.; and in sweet, 72.06 per cent.

During the third period the mortality was very low, owing no doubt to the fact that by this time practically all the larvae had become established. The mortality for the period being, in dent, 3.64 per cent.; flint, 3.98 per cent.; sweet, 2.55 per cent., the cause of death not being attributed to any one factor.

The mortality during the last period when all the larvae had become full grown and which deals with the late season, after the corn would normally have been cut, is practically nothing, especially in flint and the sweet corn, being, in flint, .31 per cent.; in sweet, .79 per cent., the dent corn being slightly higher, 2.76 per cent. Those dying during this period are mostly those that become pinched by the breaking over of the stalks, the breaks occurring in most cases where the stalks have been weakened by the borers. The records did not show any diseased or parasitized larvae.

The mortality for the season in the larvae recovered up until the time of corn cutting in each of the three types was, in dent, 8.98 per cent.; flint, 9.44 per cent.; and in sweet, 3.44 per cent. However, to have a true estimate of the percentage reduction from those hatching, there must be added to this the number unaccounted for and presumed dead. Thus we have a reduction in the dent, of 90.30 per cent., flint, 86.79 per cent., and in the sweet, 63.16 per cent. With the exceptions of the sweet corn this tallies very closely with the results obtained at Harrow in the summer of 1923, where there was a seasonal reduction in dent of 83.67 per cent., flint, 82.01 per cent., and in sweet of 87.83 per cent.

From the results it was shown that approximately 75 per cent. of those failing to survive are eliminated during the first and second instars, and that the death rate decreases abruptly as the larvae increase in size.

THE INTRODUCTION AND COLONIZATION IN ONTARIO OF TWO HYMENOPTEROUS PARASITES OF THE EUROPEAN CORN BORER

A. B. Baird, Entomological Laboratory, St. Thomas, Ontario

The history of the European Corn Borer on this continent has been rehearsed on several occasions and I need not repeat it here other than to mention that it was first reported from the United States in 1917 and was discovered

in Ontario in 1920, being then confined to two small areas in the vicinity of Welland and St. Thomas. It has increased and spread with amazing rapidity and in Ontario it now covers practically all of the western peninsula, and the damage done in 1924 was conservatively estimated at considerably more than a million dollars.

In view of this very rapid increase and the many difficulties in the way of its control by artificial means the Dominion Entomological Branch decided to follow the lead of the United States and endeavour to assist in the natural control of the pest by the introduction of insect enemies, or parasites, from its native home. Knowing the value of parasites in the control of insects generally, the United States Bureau of Entomology sent one of its entomologists to Europe in 1920 to study the corn borer in its native home, and as a result of his findings some eight species of parasites which attack the corn borer larvae in Europe have been colonized in the United States.

Through the courtesy and kind co-operation of the U. S. Bureau of Entomology we have received breeding stock and full instructions regarding the technique of handling the parasites from their parasite laboratory at Arlington, Mass., and we are greatly indebted to those in charge of the laboratory operations for the very cordial assistance we have received. The parasite laboratory at St. Thomas was opened up by the Branch in the middle of May, 1923, and the breeding of parasites was commenced about two weeks later. Up to the present only two species have been introduced, viz.: *Habrobracon brevicornis* Wesm. and *Exeristes roborator* Fab., both of which lend themselves rather readily to laboratory breeding on account of the fact that their larvae feed externally on the full grown corn borer larvae.

Habrobracon brevicornis is a small hymenopterous fly measuring about 3 mm. in length. The female is provided with a comparatively short, sharp ovipositor and has normally much shorter antennae than the male. When attacking borers in the field the female locates the entrance to the tunnel, enters, and follows it until she reaches the borer; she then stings her victim in one or several places and feeds on the juices exuding from the punctures and when it has become somewhat paralyzed deposits her eggs singly over the surface. During warm weather the eggs hatch in 24 to 36 hours and the larvae become full grown in 3 to 5 days; they then spin tough white cocoons, on or near the remains of the dead borer, in which they pupate, and the adults emerge 5 or 6 days later. An average of about twenty-five parasites will develop from each borer and each female is capable of depositing from 500 to 600 eggs. The number of generations a year has not been determined but they are probably 5 or 6 at least and so far as known the species spends the winter only in the adult stage.

The breeding stock received yielded 835 female flies and about twice as many males and from these a total of 595,000 were reared and liberated in the St. Thomas district during the summer and fall of 1923. A small breeding stock was kept going through the winter and our liberations this year totalled 486,500; making a grand total now liberated of 1,081,500 flies. These were all liberated in the St. Thomas district with the exception of 30,000 liberated this fall (1924) in the vicinity of Coatsworth, Kent County.

Exeristes roborator is a rather large Ichneumon fly measuring about three-fourths of an inch in length. The female is provided with an ovipositor almost as long as her body and having located a borer in a stalk she drills through and stings it in its tunnel and then deposits her long whitish egg on the surface of its body. The life cycle is about the same as that of *Habrobracon*, the length

of time spent in each stage varying in both cases with the weather conditions. Only a single *Exeristes* develops from each corn borer larva and each female fly is capable of depositing about 125 eggs spread over a period of several weeks. The insect winters as a full grown larva in a cocoon which it spins inside the stalk near the remains of its victim. Nature has provided a rather ingenious method for tiding this species over periods of host scarcity in that larvae spinning cocoons on the same day will produce adults over a period of several months.

The laboratory breeding of this species was begun in February of this year (1924) from a shipment of cocoons which gave us ninety-three female and forty-four male flies and from these we were able to breed up and liberate 15,850 flies during the spring and summer. All were liberated in the vicinity of St. Thomas with the exception of 350 at Stoney Point, Essex County, and 400 at Coatsworth, Kent County.

In connection with the method of liberating the parasites; in the case of both species the adults are allowed to emerge in cages at the laboratory. As there is a preoviposition period of two to six days they are fed and held for two or more days during which time mating takes place so that when they are taken to the field and liberated the females are practically all mated and ready to begin egg laying as soon as a suitable host is located. In the case of *Habrobracon* about forty per cent. of the flies liberated were females and of *Exeristes* about seventy-five per cent. females.

No attempt has been made to recover the parasites in the field as the chances of recovery during the first two or three years after liberation would be very slight and our staff for this work being so small it was felt that the time was being spent to better advantage in breeding up as many parasites as possible for liberation. Our chief limitation in the production of parasites is the procuring of an abundant supply of host material. Upwards of 175,000 corn borers have been used in the work to date and the collection of these has taken up a great deal of our time.

A BRIEF NOTE ON FARM CUTTING BOXES AND CORN SHREDDERS AS FACTORS IN THE CONTROL OF THE EUROPEAN CORN BORER (*Pyrausta nubilalis* Hubn.)

G. A. Ficht and R. H. Painter, Entomological Branch, Ottawa

In order to obtain some definite information on the importance of farm cutting boxes and corn shredders in the control of the European corn borer (*Pyrausta nubilalis* Hubn.) a study was made of these farm products during the fall of 1924, using dent and flint, the two main types of fodder corn.

The average farm cutting box is not adjustable to cut more than one length and is usually set to cut about three-quarters of an inch. The actual length of cut, however, varies somewhat according to the rate at which the machine is fed. In the larger types of cutting boxes which are used for silo filling, the cut is adjustable to from four to six different lengths, varying from one-quarter to one and one-quarter inches.

Dent corn stalks, which were cut approximately three-quarters of an inch long and examined almost immediately after cutting, showed the mortality of the larvae, which were contained in them, to be 81.48 per cent., while 60 per cent. of the larvae that escaped the knives died within the next ten days, making a total mortality of larvae in dent corn of 92.59 per cent. Further observation on

the live larvae, made fifteen days after cutting, showed no further increase in the death rate. The balance of the larvae are being kept under observation.

In the flint corn cut at the same length, the mortality of the borers at the time of cutting was 75 per cent., while ten days later the total mortality had reached 77.94 per cent. Another examination five days later showed the total mortality of larvae in flint corn to be 80.70 per cent. The higher mortality in the dent corn was probably due to the fact that the dent corn stalks were much greener at time of cutting than the flint and were crushed more completely by the cutting operations.

There are a variety of corn shredders in use throughout the corn area of Ontario. The one under observation has five main outlets for corn cobs, shelled grain or stalks, through which European corn borer larvae may also escape during the shredding process. Thus, in dent corn, 16.79 per cent. of the borers leaving the machine came out underneath with the chaff and dirt directly after the stalks left the knives, and these showed a mortality of 70.58 per cent. With shelled grain and small pieces of cob, there escaped under the blower at the rear end of the machine 19.74 per cent. of the borers, among which there was a mortality of 70 per cent. Of the 54.54 per cent. of the larvae which came out with the shelled grain from the elevator and grain spout 56.84 per cent. had been killed. Only 7.7 per cent. of the larvae went into the mow with the stalks from the blower and these showed a mortality of 66.66 per cent., while the 1 per cent. of the larvae which left the machine in the cobs themselves escaped injury. This makes a total mortality of 61.85 per cent. of the 506 larvae examined soon after the shredding operations had been performed and from the nature of the observations it was reasonable to suppose that at least 90 per cent. of the larvae were under observation.

The mortality of larvae in flint corn shredded under practically the same conditions was nearly the same as that of dent, there being only a fraction of a per cent. difference with 1,363 larvae under observation.

After an interval of ten days an examination of the live larvae which had passed through the shredder showed a mortality of 62.20 per cent. and five days later a further 11.02 per cent. had died, making a total of 71.53 per cent. of the borer larvae killed directly or indirectly in dent and flint corn during shredding operations.

Considering the high death rate of larvae associated with both processes, the small residue of living larvae in the treated material and the fact that this residue is largely killed in the later feeding of the treated stalks, too great emphasis cannot be laid upon the value of the cutting box and the shredder.

DISCUSSION ON CORN BORER

Mr. Caffrey: After hearing the discussion this morning, I think you men have to contend with the same handicaps that we have to contend with in the United States. The corn borer is not a spectacular insect and to many of the farmers seems insignificant. If it did a lot of spectacular damage it would be much easier to get farmers to deal with it at once. In Hungary some of the cornfields are very severely injured by the borer at times, the damage occurring chiefly to the stalks, yet most of the farmers blame this injury to the character of the season or to poor seed or to any one of a dozen causes rather than to the real cause. Over there, just as here, they do not appreciate what the corn borer is doing.

As to parasitism, European investigators assured us that there was little or no parasitism in Europe and many entomologists are of the opinion that it is hopeless to expect anything from parasites. However, eight species have already been discovered in southern Europe. One of these species parasitized about fifty per cent. of the borers in weeds in the Paris region. In southwestern France parasites accounted for about forty per cent. of the borers and in northern Italy about twenty per cent. In Hungary, Mr. Babcock found that about twenty per cent. of the overwintering larvae in certain fields were parasitized by *Habrobracon brevicornis*. This encouraged us, so we have started to liberate this species in Ohio, and in addition we have secured material from Hungary which may prove more effective than the material from France. We have had a little better success with *Exeristes roborator* than with the species just mentioned. There are vast areas in Europe and Asia from which parasites may still be obtained. I had a personal conversation with a man who spent some time in China and who witnessed an outbreak around Shanghai. He reported that there were two species of Tachinas which were doing valuable work there. No one, of course, can forecast at present how important parasites may become ultimately in controlling the corn borer in North America.

I was glad that the matter of legislation for the corn borer had been considered. Some of the entomologists in the United States feel that legislation is absolutely necessary for a solution of the problem. It seems to me we must bring some pressure to bear upon people who will not clean up and that they must be forced to do so. In the State of Massachusetts a law has been passed compelling clean-up of corn. This law, we believe, has given valuable results and the destruction of remnants of corn in that district has certainly reduced the number of borers greatly this spring. Moreover, people soon form the habit, once they start, of getting rid of the cornstalks. I hope to see the time when part of every farm's routine will be to take care of its corn remnants. That will go a long way towards solving the problem.

MR. McLAINE: How did the borer get established on Long Island?

MR. CAFFREY: So far as we can determine, it was from the introduction of broom corn.

PROF. CAESAR: Did you find the borer attacking weeds or vegetables not in or close alongside cornfields in the states bordering on Lakes Erie and St. Clair?

MR. CAFFREY: No. Our experience is that in these states it is a rare thing for the borer to be found in any weed or plant any distance from the cornfields. Of course they sometimes enter large weeds among the corn.

MR. DEARNESS: Are the eggs ever laid on weeds?

MR. CAFFREY: Yes. In the New England States eggs are laid on a great variety of plants. There are two broods in these areas, but in the districts along Lake Erie we have found the same conditions in regard to egg-laying as you have had in Ontario, namely, that eggs are seldom laid anywhere except on corn. Of course we do not know that this condition will always remain true.

PROF. CAESAR: Have you any data on whether the moths this year laid more eggs per moth than last year?

MR. CAFFREY: In the Silver Creek and Sandusky areas the number of eggs per moth in confinement was about double what it was last year, so that it does seem as if the season had some effect upon the number of eggs the moths lay.

PROF. CAESAR: This year our worst infestation was along the shore of Lake Erie, where it was exceedingly heavy for about fifty miles. As we went

farther back into the county the infestation became much lighter in most cases. Now the question in my mind is—Had proximity to water any effect upon the amount of infestation?

Mr. Caffrey: If we were to judge by what occurs in the Old World I should say that proximity to water is not an important factor, for there is usually a heavy infestation on the dry plains of Hungary. Some have said that the borer will never become a severe pest except near lakes or other large bodies of water, but judging from its behaviour in its native habitat I should not like to depend upon this prophecy. There may be some relation between bodies of water and borer distribution.

Dr. Dearness: Are some varieties of corn less susceptible than others?

Mr. Crawford: So far as we can tell larvae establish themselves with equal ease on any variety of corn. We once thought that they had more difficulty in establishing themselves on dent than on flint, but we no longer think so.

I am not much impressed with the idea that the past season has been specially favourable to the increase of this insect. Experiments were conducted last year at Harrow to determine the percentage of larvae that survived and it was found that sixteen per cent. came through the early instars safely. Figures this year, three weeks after the eggs finished hatching, showed that twenty-two per cent. had come through. The difference between the two years is therefore not very great. Last year there was practically no rain at Harrow, so I am beginning to feel that the increase this year has been due to cropping methods and the tremendous number of worms carried over. The results on our two mile square area tend to show this.

Prof. Caesar: I am afraid I cannot agree with Mr. Crawford on this point. He has taken into consideration only the effect upon larvae. That, however, is only one side of the matter. I, myself, think that the weather this year was more favourable than other years to the larvae, but even though the mortality of larvae both years was the same it may be possible that the season favoured the moths greatly. For instance, the greater amount of moisture this year and the darker and cooler weather may have enabled moths to live much longer and to lay twice as many eggs as last year and as they would have done under different conditions of weather this year. Moreover, this year, while hunting for larvae for burial purposes, I was much surprised to find that they were very difficult to discover. There were numerous holes in the stubble but in the great mass of cases the larvae had disappeared. So far as I can judge it was harder to find larvae this year than it was in the year 1922. We must remember, too, that in 1921 there was a great decrease in the infestation, not only in Mr. Crawford's two mile area but also in all the area between St. Thomas and Port Stanley. The plowing that year was no better done than in the average year and the clean-up of stalks and refuse was not a bit better than usual, so I cannot help believing that much of the reduction that season was due to unfavourable weather conditions. I should like to hear from Mr. Caffrey on this point, for if the weather was not a great factor this year then I think the situation is exceedingly discouraging.

Mr. Caffrey: At Sandusky, Ohio, there were twice as many eggs laid in confinement as last year, which would suggest more favourable weather conditions for the moths, but I do not know whether the same would hold true in the fields. We know, of course, that heavy cold rains will halt the deposition of eggs.

Dr. Metcalf: When infested stubble is plowed under do the borers stay

down? If they do how long do they live? If they come to the surface, what becomes of them?

MR. CRAWFORD: If corn refuse is plowed under as early as the 7th of September in a reasonably warm autumn, eighty-five per cent. of the larvae come to the surface. As the season advances the proportion coming to the surface decreases and in November practically none come up. Soon after growth begins in spring the larvae begin to work their way to the surface and continue to do so until the latter part of May, by which time all the larvae have left the buried material. Those that pass the winter under the soil remain there in perfect health until spring. The mortality from winter both above and below ground is very low. After the larvae come to the surface we do not know what becomes of many of them. All we know is they have not gone back into the soil, also they are not in the grass or rail fences. They simply seem not to exist. We have tried our best to watch where they go and after observing some for five days we found that they had not wandered far away from where they started.

MR. CAFFREY: We too do not know what becomes of the great bulk of the larvae. We have tried numerous devices to settle this point but have not been successful.

PROF. CAESAR: I should like to encourage Dr. Metcalf by telling him that we gathered 1,800 larvae last year in stalks and stubble and placed them in furrows six inches deep, covered them with the plow and left the plot untouched until we knew that the moths were coming up. We then put six large cages over the ground and examined daily for moths until the season of emergence was past but did not find a single one. We also sifted most of the soil beneath the cages and found no traces of pupae. We had barriers so that we might catch the larvae if they wandered some distance from the plot, but there were none found in these barriers more than a few feet away from the plot.

MR. PETCH: What is the financial loss caused by the borer?

PROF. CAESAR: The point is not what it is now, but what it is going to be after the insect has increased tenfold. On the 20th of September I was in a field at Sparta where seventy-five per cent. of the tassels were then broken over and fifty per cent. of the stalks broken down. What would these fields be like if there were ten times as many borers?

DR. DETWILER: Will the presence of larvae in the stalks affect silage?

PROF. CAESAR: The silage of course would not be as nice, on account of a certain amount of rot in the burrows, but we have no indication of its injuring cattle.

THE OUTBREAK OF THE GIPSY MOTH IN QUEBEC

LEONARD S. MCLAINE, ENTOMOLOGICAL BRANCH, DOMINION DEPARTMENT OF AGRICULTURE

There are few insects on the North American continent which have received as much publicity as has the gipsy moth—an insect innocently introduced (1868) into the Boston district by a French scientist in connection with his experiments on the production of silk. The fact that some of his material escaped and that he announced it publicly through the medium of the scientific press caused little comment at the time, and over twenty years elapsed before it was realized that it was a serious pest. Organized effort on the part of the Massachusetts authorities succeeded in bringing the insect under control, and a few more years'

work would most likely have brought about its extermination except for the fact that, in spite of the strenuous objection of experts, all funds were withdrawn in 1900. By 1905 the insect had increased to such an extent that control work could not be further delayed, and having spread over twenty-five hundred square miles, all hope of extermination was abandoned. From that time on the insect has been slowly spreading in all directions, like an encroaching sea, in spite of the millions of dollars that have been spent in an endeavour to stem the tide. At the International Conference held in 1922, it was realized by all the officials present that strenuous efforts must be made to confine the insect to its present boundaries, otherwise it would gradually infest all the forest areas on the Atlantic seaboard, and that the appropriation needed for control work would increase in proportion to the amount of territory involved. It was also appreciated that there would be a limit to the amount of funds that could be made available for this work. To meet this situation it was agreed that a barrier zone should be established, twenty-five miles wide, running approximately from Lake Champlain to Long Island Sound, and every effort was to be made to prevent the gipsy moth crossing or becoming established in this zone. Canada's part was to prevent the insect from becoming established across the international boundary and encircling the barrier zone.

In 1923, extensive scouting operations were carried on by the United States Bureau of Entomology and the New York State authorities in the "barrier zone" and a number of infestations were found. The Canada Department of Agriculture had been carrying on intermittently for a number of years scouting work in southern Quebec north of the Vermont and New Hampshire lines. In the late fall of this year (1923) the largest single gipsy moth infestation ever found in New England was discovered at Alburgh, Vermont, within one-half mile of the Canadian border. The discovery of this infestation emphasized the need of intensive and extensive scouting in Canada to determine whether or not the gipsy moth had invaded the Dominion. Plans were immediately inaugurated to get this work under way.

During the summer of 1924 sufficient sums of money to undertake this work were appropriated by the Canada Department of Agriculture and the Quebec Department of Lands and Forests. A total of thirty-six men have been used on this work, which started the early part of July. After receiving some preliminary training both in Canada and at infestations in the United States, the men were assigned to their territory under the supervision of a general foreman and an associate general foreman. The territory, which extended from Chateauguay County on the west to Compton County on the east and north from the international boundary about thirty miles, contained approximately four thousand linear miles of road. This area was divided into eight districts and a foreman and three scouts were assigned to each district. Each tree examined by a scout was marked with a distinctive sign; expert scouts, or trailers, were employed to re-examine the territory worked to see that no trees were missed.

An innovation in handling scouting crews was inaugurated this past summer, in that each crew was provided with two "bell" military tents, folding camp beds, chairs, tables, blankets, etc. By the utilization of this camping equipment a considerable amount of money was saved on lodging; the men, however, took their meals at boarding houses, farm houses, etc.

Experience in carrying on scouting operations in the United States over a long period of years has revealed the fact that, with very few exceptions, new and recently established infestations have been found on single isolated trees or

orchards, and woodland infestations occur only after the insect has become established in a district. For this reason the scouting in southern Quebec has been confined to roadsides, orchards, isolated trees in fields and hedgerows.

On July 29th (1924), A. K. Gibson of the Federal staff established the first record of the gipsy moth in Canada, by finding a single isolated egg cluster near the village of Beebe, Stanstead County, Quebec. The egg cluster was sent to the Gipsy Moth laboratory at Melrose Highlands, Mass., for examination, and the eggs proved to be infertile. Thorough and careful scouting throughout the entire district failed to reveal any further trace of the insect.

Five weeks later (September 3rd) a severe isolated infestation was found by A. Magnan of the Provincial staff, on the Belle Vallee Road, Lacolle Township, St. Johns County. From the information available at the present time the infestation is confined to four farms on opposite sides of the road, and includes orchard and shade trees. An old willow tree adjacent to the road and adjoining an old stone wall is the centre of the outbreak. Clean-up operations are now under way and judging from the number of egg masses creosoted to date, it would appear that approximately three thousand egg clusters will be found. Seven hundred are located on the willow tree and over a thousand have been found so far in the stone wall. Orchard trees, fences, old apple trees and the farm buildings are known to be infested and the infestation covers at least six hundred square yards.

The "clean-up" operations now being carried on include the creosoting of all egg masses found, removal of old apple trees, the burning of brush, the filling of cavities in healthy trees, the examination of all buildings, fences, etc., in the vicinity and the thorough re-scouting of the entire district. In the spring, extensive spraying will be carried on, which will include all trees within six hundred feet of the last egg cluster found, the banding and tangle-footing of infested trees, and the burning over of infested stone walls at the time the eggs hatch. By these means it is hoped that the colony may be exterminated.

Although an attempt has been made to trace the origin of the outbreak, the results thus far have been unsuccessful. The Alburgh outbreak is approximately ten miles away, but no egg clusters have been found between the two colonies which more or less eliminates the idea of possible windspread. There is no doubt that the Lacolle infestation has been there for some years, judging from the number of egg clusters found and also from the age of some of the old clusters. The owner of the property on which the outbreak occurs recalls the pest being present at least two years, but indications point to the fact that it is older than that. The majority of farmers in the district concerned have relatives in the New England States and there remains the possibility that the pest may have been introduced by infested materials brought by relatives on a visit to Lacolle from the infested area in the United States. The fact is, however, that it was most fortunate that the infestation was found this year, not only from the standpoint of control, but also on account of the outbreak occurring west of the eastern line of the "barrier zone" in New York State.

A STUDY OF THE METHODS USED IN GROWING ENTOMOPHTHOROUS FUNGI IN CAGES PRIOR TO THEIR ARTIFICIAL DISSEMINATION IN THE ORCHARDS

Alan G. Dustan, Entomological Branch, Ottawa

The investigation which led up to the present study was commenced in the summer of 1921 when the first real effort was made to artificially spread in the orchards of the Annapolis Valley, Nova Scotia, two parasitic fungi which were found attacking the European Apple Sucker (*Psyllia mali* Schmidburger) and the Green Apple Bug (*Lygus communis*, var. *novascotiensis* Knight). Previous to 1921 the controlling effect of these diseases had been fully recognized, but it was not until that year that any effort was made to make use of the diseases in checking the ravages of these two most important apple pests of the Annapolis Valley.

Shortly after this work was undertaken it became apparent that nature could not always be relied upon to produce outbreaks of disease in the field early enough in the season to allow of their being widely spread before cold weather set in, checking the growth of the fungi. Accordingly, it was seen that, if possible, some means must be devised for starting epidemics earlier in the summer and it was decided to make an effort to rear these fungi in cages where the temperature and humidity could be regulated to some extent and where the number of host insects could be increased at will. If such a method could be perfected it was hoped by this means to be able to develop epidemics of these diseases each year in cages, in the early part of the summer, and then transfer the fungi into the orchards where outbreaks could be started artificially in seasons when the diseases did not occur naturally in the field.

At the commencement of the cage work one fungus only was studied, namely, *Entomophthora sphaerosperma* which is parasitic on the Apple Sucker, but as the investigation developed and our knowledge increased the Green Apple Bug fungus, a new species of *Empusa* recently named and described as *Empusa erupta*, was also grown in cages.

It might be mentioned here, before going on to a detailed discussion of our cage methods, that every effort has been made in the past to grow both these fungi in the laboratory on artificial media but without success. Continued efforts will be made, however, to gain this end, for it is realized that if it is possible to culture the diseases a new field of usefulness may be opened up thereby, and in this way much, or all, of the labour in connection with the cage work dispensed with.

Small Cage Work

At the commencement of the work three types of cages were tested out, namely, frame cages covered with plain, untreated factory cotton; similar cages in which the cotton had previously been waxed with common parawax, and cold frame cages, having wooden sides made of matched lumber and a factory cotton top. The last mentioned cages were also supplied with tightly fitting glass tops which could be taken off when the weather was hot and replaced in the evenings or when the temperature dropped below 60 degrees. The first year all types of cages were small, averaging about twenty inches high, fifteen inches wide and thirty inches long, but the next year most of these were increased greatly in size, some of them covering fair sized apple trees and being twenty feet, or more, in height.

All of the small cages were built over young, low-growing seedlings upon which the insects to be infected lived and fed. In most cases the insects were collected and introduced into the cages in the adult stage the year in which the test was being made, but occasionally the seedlings were infested with eggs the previous fall and enclosed in cages before hatching took place in the spring. As far as could be ascertained one method was just as satisfactory as the other in carrying on adult infection tests, but where it was desired to start an epidemic among the nymphs it was found better to have the seedlings infested in the fall.

Resting spore material, which had been collected the previous autumn and wintered over in ground cages, furnished the chief source of infection for our cage work, but occasionally diseased insects discharging summer spores were collected in the field and introduced into the cages. Sometimes such insects belonged to the same species as was being experimented with, but more often they belonged to another family or order. The diseased material was placed on the ground at the base of the seedlings, pinned to the walls and top of the cages, or else fastened to the leaves of the young plants. As far as could be learned it mattered little where the infected material was placed, but as the new epidemic usually started low down in the cages and as the disease winters over naturally on the ground, it seems reasonable to suppose that best results would be obtained when the overwintering spores were placed on or near the soil.

As has already been mentioned, the object of growing these fungi in cages is to start an epidemic among the insects to be infected earlier in the season than takes place naturally, in order that there might be sufficient material to spread throughout the orchards in the earlier and warmer parts of the summer. Investigations have proved that this unnaturally early development of the diseases in cages takes place as a result of three factors which can be more or less regulated under cage conditions, namely, higher temperature, increased relative humidity, and a greater crowding of the host insects. Our study has shown that these three factors are very closely interrelated, and if any one of them becomes modified, for any reason, the whole balance is upset with the result that fungus growth at once ceases. For instance, should the temperature drop below, or rise above, a certain point and the other two factors remain constant, growth is at once interfered with. On the other hand, if the atmosphere should become too dry, notwithstanding the fact that an optimum temperature prevails and the host insects are to be found in abundance, fungus growth is immediately checked. And similarly, even where the temperature and humidity are favourable no marked growth of the fungus can take place if the insects to be infected are not present in large numbers. There is no doubt that if these three factors are properly regulated, either in cages or in the field, that an epidemic is sure to result. Light is a fourth factor that has its influence on the growth of fungi, but in our work no thought had to be given to its regulation. It was found that fungi always refused to grow in cages where the light was completely excluded, but our experiments showed that they seemed to flourish with equal vigour in strong or weak lights. So in our cage work the chief aim was to increase and regulate the temperature, to produce a higher and more even relative humidity, and to so congest the insects in the cages that an epidemic once started would quickly spread from host to host. The last mentioned was easy of accomplishment, but it was found to be a very difficult task indeed to accurately regulate the temperature and humidity under cage conditions.

At the commencement of our study it was found that the temperature varied very considerably with the different types of cages used, and that in all

cages the temperature was higher both in the daytime and at night than it was in the open. This gave us a possible line to develop and a series of experiments were started, in which a hygrothermograph was used, to test out the exact temperature and humidity in different types of cages. After experimenting with a great variety of cages the three kinds already described were selected as the most suitable and a further test was carried on in order that only the best of these might be used.

It was found that the highest temperature was reached in the waxed cages. The cold frame cages came next, and the untreated factory cotton cages showed the least thermal increase of all. To give some idea of the increased temperature obtaining in these cages our records show that when the maximum temperature stood around 80 degrees in the shade outside, the factory cotton cages showed a maximum of 85 degrees, the cold frame cages a maximum of 91 degrees, and the waxed cages a temperature of 101 degrees. The minimum temperatures in the different cages did not show as much variation as the maximum temperatures, although the minimum in all cages stood about 6 degrees higher than the prevailing temperatures at the same time in the open. It is interesting to note in this regard that the minimum in the cold frame cage never dropped quite as low as it did in either the factory cotton or waxed cages.

Due to the extremely high temperature that prevailed in the waxed cages, they had to be discarded since it was found that in the middle of the day many of the insects enclosed in these cages were killed off by the heat. They might, however, have a certain use in the spring when the weather is cold, but even that is questionable.

In so far as temperature is concerned then, the cold frame cage is seen to be preferable to both the cotton and to the waxed cages for several reasons, among which only the more important will be enumerated. It has a slightly higher maximum temperature in cold weather, but not high enough to cause any mortality among the insects in midsummer. It has a more even temperature during the day and night, the minimum not being quite so low as that found in the cotton or waxed cages. Due also to the fact that it is fitted with a movable glass top and wooden sides the temperature can be kept up more easily during cold weather which would check the growth of the fungi in the other types of cages. This last feature has the added advanatage of protecting the insects from drenching rains and of preventing the diseased adults from being washed off the leaves to the ground.

In studying various methods that might be used for increasing the relative humidity in cages, it was found that here too the type of cage had a great bearing on the result. The three standard types of cages were again experimented with, and in this respect the cold frame type of cage again showed superiority. In the cotton cage the average maximum relative humidity for a certain period stood at 91 degrees, in the waxed cage it stood at 93 degrees, and in the cold frame cage 94 degrees. The minimum average in the cotton cage was 54 degrees, in the waxed 55 degrees and in the cold frame 66 degrees. Averaging the minimums and maximums in each case we find that the mean relative humidity in the case of the cotton cage was 72 degrees, in the waxed cage 74 degrees, while in the cold frame cage it was up over 80 degrees. This must of course be due to the fact that the cold frame cage, on account of its wooden sides, holds the moisture evaporated from the soil and imprisons it for a time before it rises into the air. From this it can be seen that in its ability to produce an increased temperature and a higher relative humidity the cold frame cage is superior to all others.

An effort was made to increase the relative humidity in the different cages by the use of warm water. This water was either sprayed in a fine mist on the outside of the cages, sprayed inside the cages, on the walls and seedlings, or else poured on the ground at the base of the enclosed seedlings or trees. As far as could be learned all three methods gave equally good results. Due, however, to the fact that the first two methods drowned and otherwise killed a great number of the insects, the method whereby the water was placed in the soil within the cage was the one most generally adopted. In some cases a very fine mist, with little pressure, was used with good results, but great care had to be exercised in applying the spray. It was found that the relative humidity in a cage could also be increased to an appreciable extent by building it over water-soaked soil as is found along the banks of low streams, or by constructing it directly in the bed of a brook so that the water flowed through it. In either case a more or less saturated atmosphere resulted.

By using the cold frame cage and wetting the soil within two or three times each day, preferably morning, noon and night, no difficulty was experienced in keeping up the relative humidity.

As would be expected, the weather had a great bearing on the growth of fungi in the cages. When the temperature outside remained low for comparatively long periods of time the temperature inside the cages dropped a corresponding number of degrees, with the result that the growth of the fungi was greatly checked or ceased altogether. The amount of rainfall also had its effect on the relative humidity of the atmosphere in the cages. Where the precipitation was heavy and continuous the humidity in the cages was regularly and evenly high, while during dry spells the atmospheric moisture in the cages became greatly reduced. This also had a marked effect on the development of the diseases.

Adverse weather conditions always caused the fungi to grow atypically. In some cases they would form only resting spores, or else they might give rise to long attenuated mycelial threads, resulting in a loose, fluffy growth quite unlike the tightly compacted mat of mycelium that normally grows out and surrounds the body of the insect. On mycelium of this type it was a very rare thing to find conidia or resting spores. In extremely adverse weather growth of the fungi ceased altogether and the organisms remained dormant until more suitable conditions for growth were encountered.

Summing up the data which has been collected in regard to the growth of entomophthorous fungi in cages the following points should be noted:

(1) Where possible, arrange to have the seedlings or trees to be used in the cages infested with eggs of the host insect in the fall in order that a large and ready supply of material may be available early in the spring. (2) Always use the cold frame type of cage, fitted with a removable glass top which fits over a stationary factory cotton covering. This cage is best in practically every respect, giving at all times a higher and more constant temperature and relative humidity. (3) Fungus material (resting spores) should be preserved in ground cages over winter and in the spring placed inside the cages to be infected, either on the ground or around the sides. (4) The temperature can be controlled to a certain extent by proper manipulation of the glass covering with which the cage is fitted. In cold weather this should always be put on in the evening and removed in the morning, especially if the day is warm. (5) The relative humidity can be increased by dampening the soil in the cages three or four times per day, preferably morning, noon and night, or else by spraying the enclosed seedlings and cage very gently with a fine mist spray. This also should

be done three times each day, or even oftener during very hot, dry weather. (6) This work should be started as early in the season as the temperature will allow, in order to get a supply of the fungus growing at the first possible moment.

Large Cage Studies

As soon as the fungus appears in the small cages some of the diseased forms should be immediately transferred to large field cages where a more extensive supply of the fruiting stage of the fungus may be reared for distribution in the field. As the question of warmth is not so important at this time of the year as it was earlier in the season, these field cages can very well be made of factory cotton. The cages should cover fair sized trees and should be at least six or eight feet high. A very convenient size is six feet high by three feet square. Larger cages can be used to advantage, but due to the high cost of the cotton this size will serve the purpose very well.

The diseased insects in the small cages are collected on the leaves to which they adhere, and these leaves pinned to the foliage of the tree in the large cage, being placed comparatively near the ground and in such a position that the spores, when liberated, will be shot down on the insects below.

These cages should also be gently sprayed with warm water three or more times daily or else the soil inside the cages dampened several times each day in order to keep the relative humidity as high as possible.

When the disease appears in the large cages, collections of healthy adults should be made in the field and introduced to take the place of those that have been killed off. As soon as the fungus becomes epidemic diseased material may be collected and distributed in some low, thickly-planted orchard where the host insect is abundant. This orchard will serve as the first centre of infection and the fungus spread widely from it into the surrounding country.

Acknowledgment

During the planning and carrying out of this work the writer was assisted very greatly by Mr. F. C. Gilliatt whose services it is a pleasure to acknowledge.

NOTES FROM A STUDY OF NEPTICULA POMIVORELLA, PACKARD

Harold Fox, University of Western Ontario, London

These notes are the result of observations made in connection with a study of the animal ecology of the apple tree. Since the work was not started until October 1st, only some of the stages in the life history of the animals could be observed.

In the course of this general study, I became particularly interested in the serpentine leaf miner *N. pomivorella* because of the peculiar appearance of the mine and its abundance.

The mine (Figure 2E) is generally serpentine and may be seen best from the dorsal surface of the leaf. It is from 2.5 to 5 cm. in length and gradually widens from about 0.1 mm. at the origin to an average width of 2 mm. at the large end. Near the end is a crescent-shaped opening through which the larvae escapes before pupating. Farther back the frass begins. It is first massed along the middle line but soon takes on a peculiar arrangement. It is deposited in small elliptical pellets on the upper epidermis of the leaf. This gives to the mine an

appearance unlike that of any other miner observed in the apple leaf. About two-thirds of the distance from the end of the mine the frass becomes massed along the middle line again and continues so to the origin.

The egg was found still in position, at the end of the mine, on the ventral side of the leaf (Figure 2A). It is elliptical in shape, the average length of the axis of the ellipse being approximately 0.1 mm. and that of the shorter axis, 0.08 mm. It is flat along one side and is stuck fast to the lower epidermis of the leaf (Figure 2D). Its position and the fact that some of the eggs were more flattened than others would lead one to believe that the egg, when laid, was soft, sticky, and rounded, and that the flattening was due to surface tension phenomena while drying.

The emerging larva evidently eats its way out of the egg on the side next to the leaf. The hole made can easily be seen by turning the egg over (Figure 2C).

The Larva. The young larva eats through the lower epidermis and spongy parenchyma of the leaf to the palisade tissue, and so begins the mine. In the short time at my disposal, I was unable to find any remains of the first moult, but in accordance with the general habits of the Nepticulidae, it probably takes place about two or three millimeters from the origin of the mine. Just before the frass takes on the pellet arrangement evidence of the second moult was found in the presence of the head capsule of the second instar. About midway between this point and the end of the frass deposits the head capsule of the third instar was found. When these observations were made all the larvae were in the last stadium.

Description of the Fourth Instar. The larva ranges from 2.4 to 3 mm. in length, and from 0.7 to 0.9 mm. at its widest point. It is of a bluish-green colour and somewhat flattened dorso-ventrally.

The head is very much flattened dorso-ventrally, as may be seen from the lateral aspect (Figure 1C) and extends for a considerable distance into the prothoracic segment. What appears to be a pair of small eyes are situated on the lateral margin just posterior to a pair of very short antennae. At the tip of the head the tiny mandibles may be seen.

The prothorax does not bear appendages. On its antero-dorsal surface are two small chitinized areas (Figure 1B c.a.) and on its corresponding ventral surface there is a relatively large V-shaped chitinized area (Figure 1A and C c.a.). The meso- and metathorax each bear a pair of small protuberances which evidently function as legs.

The first segment of the abdomen is without appendages but the ventral surface bulges out along the middle line. The second, third, fourth, fifth and sixth abdominal segments each bear a pair of rudimentary prolegs. The last three segments of the abdomen are without appendages and become rapidly smaller.

Parasites on the Miner. What was evidently a hymenopterous parasite was observed on the larva. It attached itself to the side of the miner and fed on the body juices. The parasite grew very rapidly and while the host was green it remained green, but when the host turned brown the parasite did also. One of those found was extremely small and it pupated in eight days. I am attempting to rear eight of these parasites and hope to have the adults identified.

Feeding Habits. From serial cross-sections of the leaf it is evident that *N. pomivorella* lives chiefly upon the palisade tissue (Figure 3 lower). The miner avoids crossing a large vein wherever possible and it is probably this tendency that gives to the mine its serpentine appearance.

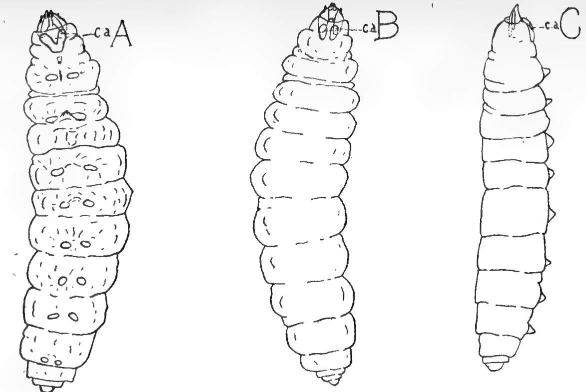


FIG. 1.—Larva of Nepticula pomivorella, 4th instar. A, ventral aspect. B, dorsal aspect. C, lateral aspect. C.a, chitinized area.

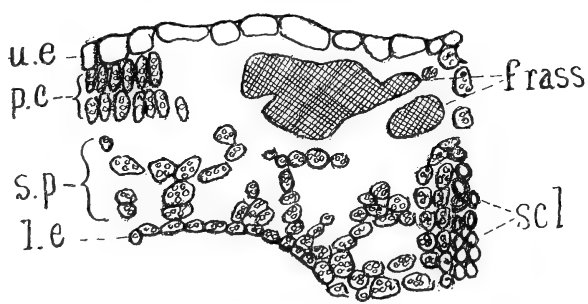


FIG. 3.—Lower—cross-section of a mine and surrounding leaf tissue, made near the origin. u.e., upper epidermis. p.c., palisade cells. s.p., spongy parenchyma. l.e., lower epidermis. scl., sclerenchyma.

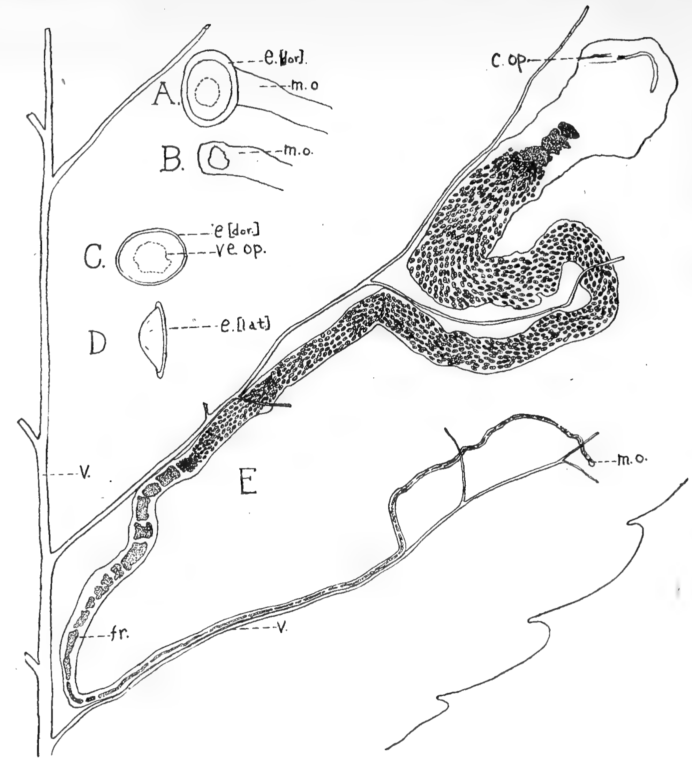


FIG. 2.—A, small egg in situ. e, egg. m.o., mine origin. B, mine origin with egg removed. C, egg. ve. op., ventral opening. D, egg, lateral aspect. E, mine of Nepticula pomivorella. v, vein. fr., frass. c. op., crescent opening.

Pupation. Before pupating the larva escapes from the leaf by cutting a crescent-shaped opening in the upper epidermis. It then migrates to a twig. In a crotch, around the base of a bud, or simply on the side of the twig, it spins a cocoon. The cocoon has the appearance of a reddish-brown scale and is somewhat longer than broad. The average measurement of five specimens was found to be 2.3 x 1.6 mm. It is covered with short, yellowish, silken strands, some of which project over the edge and evidently help to attach the cocoon to the bark of the twig.

Abundance. *N. pomivorella* was very abundant in the neighbourhood of London this year. The table following was compiled from observations made over a locality of about three miles radius around the University of Western Ontario. The first ten observations of the table were made on October 10th, the remainder on October 17th. This table shows that about thirteen per cent. of the leaves examined contained miners. These may not have all belonged to *N. pomivorella*, for at that time I did not distinguish between *N. pomivorella* and another form, very similar, but which I now believe belongs to a different species. The mine of this form is serpentine and the larva escapes through a crescent-shaped opening as does *N. pomivorella*, but the arrangement of the frass is quite different. It is massed along the middle line throughout.

I sent Miss Braun, who has made a particular study of nepticulid miners, a leaf containing one of these miners. She was of the opinion that possibly the difference in the lines of frass occurred in thin leaves and was due to the difference in the amount of food material eaten in a given length of mine. However, since that time I have found several leaves which contained both types of miners.

Miss Braun also suggested that a Crataegus miner might have transferred itself to the apple. Of course, the only sure way to decide the question is to rear moths from caterpillars of these miners.

In this work I am greatly indebted to Dr. Detwiler for his kindly advice and direction. To Miss Braun I am also indebted for help in the identification of species.

I realize that my work has been very much curtailed as I have been carrying a full quota of classes. It does, perhaps, form a beginning for further studies.

Table of Infestation

Location of Apple Trees	No. of leaves examined	No. with one miner	No. with two miners	No. with more than two miners
London—Field	100	16	3	1
London—Orchard	100	29	6	2
London—Orchard	100	11	1	0
London—Field	100	5	0	0
London—Field	100	2	0	0
London—Field	100	2	1	0
London—Orchard	100	15	0	0
London—Orchard	100	6	0	0
London—Orchard	100	25	2	1
London—Orchard	100	8	0	0
Hydepark—Roadside	100	6	0	0
Ilderton—Roadside	100	9	0	0
Ilderton—Orchard	100	20	7	2
Ilderton—Orchard	100	7	2	0
St. John's—Orchard	100	10	2	0

NOTES ON THE LIFE HISTORY OF THE LESSER CLOVER WEEVIL (*Phytonomus nigrirostis*)

H. F. Hudson and A. A. Wood, Entomological Laboratory, Strathroy

The lesser clover weevil *Phytonomus nigrirostis* is a small curculioid, that feeds on clover, and which during recent years has been slightly on the increase in Western Ontario. Little mention is made of the insect or its work in Canadian literature except possibly a note appearing in the Canadian Entomologist in 1884, by Dr. Fletcher, who found this species doing great damage to clover at Dalhousie, New Brunswick. Because of the general abundance of the insect, an opportunity was afforded to make some observations on the life history of the insect.

The Adult. The beetle is small, averaging 3.7 mm. long, and is not quite half as wide as long. The dorsal surface is green or blue-green, being due to the scales covering the dorsum of the prothorax and elytra. Head black, thorax slightly longer than wide, sides feebly rounded in front of middle, disc coarsely punctate.

Habits of the Adult Beetles. The beetles hibernate for the winter in clover fields, and are more numerous where clover debris is abundant. From our observations the beetles abound in red and mammoth clover fields, though a few can always be found where alsike, alfalfa, and sweet clover are growing.

Oviposition. Egg laying starts in the spring, the first eggs appearing in the early part of May. Our earliest record for egg laying is May 7th, and the maximum oviposition period is from May 7th to May 23rd.

Fecundity. The beetles are rather prolific, one pair under observation laid 141 eggs. The largest number of eggs secured in one day from a single female was thirty-seven, thirty-two of which were laid in the sheath, and five in the petiole. The next largest number secured in one day from a single female was twenty-three. The average daily egg laying record was six to seven eggs.

The Egg. The egg is elongate oval, length .6 mm. When freshly laid the egg is smooth and glossy. The shell being colourless the contents show through as a dirty white liquid. The second day a yellowish tinge appears, gradually turning pale greenish. The shell becomes finely sculptured on the fourth or fifth day; this is so fine, it cannot be seen with an ordinary hand lens. The first trace of marking is a delicate etching of the pattern on the smooth shining shell. This soon deepens to the usual hexagonal sculpturing. The egg darkens before hatching, the head of the larva showing plainly. Usually the day previous to hatching the larva can be seen moving within the shell, the black head being very conspicuous.

In the spring when the weather is cool, the incubation period is considerably prolonged. For instance, during the week of May 7th-13th, 1923, when forty-nine eggs were under observation, the maximum egg period was twenty-three days, the minimum sixteen days, and the average 18.73 days. From May 14th-20th with fifty-three eggs under observation the maximum egg period was twenty days, minimum fourteen days, and the average 16.18 days. From May 21st-27th the maximum egg period was fourteen days, minimum nine days, averaging 12.71 days, while from May 28th-June 4th, the maximum egg period was nine days, minimum five days, with an average of 7.93 days. In the spring of 1924, the weather being much cooler, egg laying started a little later, with the egg stage consequently prolonged. With thirty-seven eggs laid from May 12th-18th, the maximum duration of the egg stage was twenty-six days, the minimum

twenty-two days, and the average twenty-one days, from May 19th-25th with twenty-eight eggs under observation the maximum egg period was twenty-four days, the minimum twenty days, and the average 21.28 days. From May 26th to June 2nd, with ten eggs under observation the maximum incubation period was twenty-two days, the minimum fourteen days, and the average seventeen days.

THE LARVA. When first hatched the larva is very small, approximately one millimetre long. The body is whitish in colour and the head black. As it grows it becomes dirty white in colour, and moults three times. There is considerable uniformity in the length of each stadium, ranging from five to seven days for the first; four to five days for the second; three to five for the third, and six to eight days for the fourth. The average larval period in 1923 was seventeen days, and in 1924 twenty-one days. With the last moult the head becomes a light rusty brown instead of remaining black as in the previous moults.

PREPUPAL AND PUPAL STAGES. From a study of 115 specimens in the prepupal stage, the maximum length of the period was found to be six days, the minimum two days with an average prepupal stage of 3.39 days, the pupal period from 123 specimens under observation, the maximum pupal period was ten days, with a minimum of three, averaging 5.22 days. With 100 specimens in the cocoon after reaching the adult stage, the maximum period in the cocoon was two days, and the minimum one day.

THE COCOON. The cocoon is a delicate lacy structure. The average length of cocoons spun in clover heads was 4.85 mm., and the average width 2.75 mm. The cocoon is clear and transparent. Cocoons may be spun in the clover head, in the axils of leaves, or on dead leaves at the base of the plant.

THE PUPA. The average length of living pupae is 4.85 mm., and the average width 2.01 mm. The changes in colour during the early part of the pupal period are very marked. These observations were made in the third week of June, earlier in the season these stages are much drawn out sometimes lasting as long as ten days.

First day—Dorsal surface of prothorax, head and antennae pale olive green, with a pale stripe lengthwise through the centre. Legs and wing tips dusky yellow, abdomen light greenish yellow, eyes not showing.

Second and third days—Eyes showing, colouration slightly deeper.

Fourth day—Wing tips dusky, eyes very distinct.

Fifth day—Emerged.

THE NEWLY TRANSFORMED BEETLE. The newly transformed beetle is light in colour, but soon takes on a brownish shade. It remains within the cocoon from from one to two days, frequently eating part of the cocoon. When it emerges it is brown, but in from five to six days is usually of a pronounced green colour.

SEASONAL HISTORY. There is only one brood a year. On several occasions we have collected the beetles in August and early fall, but have never been able to secure any eggs.

FOOD PLANTS AND FEEDING HABITS. The adults and larvae seem to prefer red and mammoth clover. We have occasionally taken the adults in alfalfa and sweet clover fields, but never larvae. The larvae attack the newly forming buds, and such heads do not develop. The adults feed on the leaves riddling them.

ABUNDANCE AND INJURY. Although the insect has been on the increase for the past two years, it cannot be said that the clover crop has in any way been

endangered. In certain fields quite a percentage of clover heads were destroyed but from a fodder standpoint the crop was hardly injured. As there is no second brood to destroy the seed crop, the lesser clover weevil need not be considered an important pest at the present time.

ENTOMOLOGY IN THE RURAL SCHOOLS IN THE PROVINCE OF QUEBEC

PROF. GEORGES MAHEUX, PROVINCIAL ENTOMOLOGIST, QUEBEC

I do not intend to discuss in this paper the whole question of the teaching of natural sciences in rural schools. Though it might be interesting to point out the importance of some elementary lessons, for instance, of botany and zoology, to be given to farmers' children, such a discussion would take too much time and be perhaps rather outside the scope for this society. Therefore my remarks will be confined to applied entomology.

The necessity of some knowledge of entomology for the boys and girls who attend the rural schools is obvious. Too many injurious insects are established in the province, the injuries that they cause are much too great, the possibility of facing each year some new invaders, prove this necessity. In fact, the teaching in rural schools should aim to prepare the future farmer or farmer's wife to the task he will be called upon to perform within a comparatively few years. It is useless to teach them things that would not facilitate the work on the farm; moreover, it might easily be injurious for the community.

I do not mean that the teaching should be entirely confined to agricultural matters, but the directing spirit of all rural teaching should always aim to give the farmers' children a real and well equipped farmer's mind.

As far as entomology is concerned, the fight against insect pests is something very far from the routine system still in effect on many farms. To the man who never had any idea of the injuries caused by noxious insects it requires a good deal of reading before he feels convinced of the importance of these pests and before he has gathered the necessary information about the value of spraying and insecticides.

If, while at school, the boy or girl has an opportunity to know the chief injurious insects, to see them in a small but well prepared collection, to learn the means of control, such information will enable the pupil to help the parents which later on will prevent the loss of crops valued at many hundred dollars.

But the young pupil, however anxious to learn he may be, will not increase his entomological knowledge unless the teacher is interested in the subject. Therefore the first steps must be made towards the formation of the school teacher. Various methods have been tried which bear unequal results. The value of Normal Schools for the formation of rural teachers is still a question open to discussion. It is true that regular normal school courses include some elementary knowledge about applied natural sciences or nature study; but it is generally a much neglected field.

We have thought that it would be possible to interest school teachers in the matter and help them to give more attention to agricultural questions in general and especially to entomology.

In the spring of 1923, the Entomological Bureau of the Province of Quebec announced, through the agricultural press, a competition for insect and plant collections open to all rural school teachers. The Department of Agriculture

liberally offered $100 in cash prizes for the ten best collections in each class and supplied to each competitor all necessary material for collecting purpose.

Over forty teachers enlisted in each class but nearly half of them failed to submit the collections up to the autumn of 1923. We received ultimately twenty-three collections of insects and eighteen collections of plants. The collections of insects included a total of 2,232 specimens, representing an average of seven orders and forty-one families per collection. Thus each collection had an average of ninety-seven specimens, all with locality labels, and well arranged in duplicate boxes.

In the spring of 1924, the same competitions and prizes were offered again to the rural teachers, with a new section for minerals. Up to the present (November, 1924) thirty-eight collections of insects have been received with a total of 6,612 specimens with an average of 174 specimens, eight orders and fifty-three families per competitor. The number and size of plant collections has increased in the same proportions (27). As to minerals, thirteen teachers have sent in specimens.

The work of judging collections is not the most important, nor is the prize money the most satisfactory and lasting result for the competitors. If we want teachers to keep interested in natural science, or nature study, the collections properly arranged must be sent back to them. The plan we use for the arrangement of insect collections is the following. The purely systematic side is of secondary interest to the average school teacher and of still less importance to the school children. Thus only collections of particular value belonging to serious amateurs are grouped according to families, genera, and, whenever possible, to species. What we are aiming at is this: give to each competitor something that will help him interest the school children from a practical point of view, the viewpoint of applied entomology.

In dust proof wooden boxes with glass covers the specimens are grouped according to the following sections:

1. Section illustrating the principal orders.
2. Section giving the metamorphosis of a certain species.
3. Section grouping injurious insects, each clearly labelled as to kind of damage and means of control.
4. Section of beneficial insects, each with details as to usefulness.
5. Section showing the near relatives of insects or Arthropodes.

Next year we propose to add a new section giving samples of the most important insecticides.

Of course, not very many specimens can be included in such collections; but quantity is not necessary nor desirable. The choice of the representative forms and clear labelling is much more important. The ensemble must attract the attention of the young folks as the box is obviously destined to occupy a place in the class room. As a matter of fact nearly all the 1923 competitors have answered, to our questionnaire, that their collection forms now part of their teaching material and that their pupils quickly pick up information from it. A booklet of explanations for the use of teachers is in course of preparation and will help them materially.

We feel sure this method of procedure will eventually bring good results. As a matter of fact we could ourselves have prepared collections of the same type and sent then to the school teachers. But apart from the fact that a lot of material would have been required entailing much collecting, I am convinced the school teachers would have felt rather indifferent towards them. Now they are interested in entomology because they themselves enjoyed

collecting; they are pleased to show such collections because it is their own work; besides, if a label indicates that such a collection was awarded a prize there is a little tinge of pride that helps a great deal. Year after year we intend to go deeper into this matter. For instance, the 1923 and 1924 competitors will not be admitted for general collections in the future. Second year competitors will be entitled to present collections of injurious insects, preference being given to insects injurious to only one group of cultivated plants, such as vegetables, fruit trees, cereals, shade trees, ornamentals, flowering plants, etc.

Third year competitors will only be admitted for collections showing the metamorphoses of the most important pests of the province: cutworms, white grubs, cabbage worm, cabbage maggot, onion maggot, potato beetle, grasshoppers, tent caterpillars, codling moth, plum and apple curculio. Collections of this sort may require a full year to be completed, but will bring the teachers exactly to the point where we want them, and their interest in entomology will be increased very materially.

The work of teachers in entomology will be supplemented in due time by pamphlets of information as to insects in general and the control of injurious forms in particular. It will be in fact a short course by correspondence in elementary entomology.

Through the efforts of the Elementary Agricultural Education Branch with whom we co-operate in this work, the school children will have every opportunity to apply the information received at school. Inspectors will call their attention to the control of insects in the school gardens and the home gardens and give demonstration as to the use of insecticides.

We feel confident that this form of extension will bring about good results, if not immediately at least within the next ten years. It is surely not an investment for a short period but the possible results are certainly worth the amount of work we are willingly imposing upon ourselves.

OBSERVATIONS ON THE HOST-SELECTION HABITS OF PIERIS RAPAE L.

C. R. Twinn, Entomological Branch, Ottawa

The necessity for investigation to establish a better understanding of the principles of host selection was recognized by Walsh (1864–5) sixty years ago when he wrote his memorable treatises on "Phytophagic Varieties and Phytophagic Species," and has been stressed more recently by Brues (1920) who stated that, "the instinctive behaviour of phytophagous insects in the selection of their food-plants is . . . one of the fundamental principles underlying the application of entomology to agriculture, horticulture and forestry." A study of the food habits of insects is of importance in that it yields data that should prove of value in indicating the probable behaviour of introduced species, or indigenous species normally feeding on wild vegetation, when subjected to an entirely new set of environmental conditions.

Man's disturbing effect in nature as exemplified by his agricultural practices is frequently calculated to cause insects to turn from their original food plants to others. As an instance of this it may be noted that before the advent of the cultivated potato, *Solanum tuberosum* Linn., in the western United States, the Colorado potato beetle was confined to the wild plant, *Solanum rostratum* Dunal. According to Walsh (1867) the potato beetle was discovered in 1859, about 100

miles west of Omaha city, and was known for some years in Colorado feeding in great numbers on the latter plant. As this wild species of Solanum was more or less restricted in its range, the beetle had little opportunity to infest new territory, but after the introduction of the cultivated potato into its native habitat, it acquired a preference for this plant and rapidly extended its range across the American continent with results that are now history.

Gibson (1915), states that prior to 1911 the pale western cutworm, *Porosagrotis orthogonia* Morr., was not known as a pest in Western Canada, but in that year extensive damage to cultivated crops, including several kinds of grain, flax, alfalfa and beets, was reported from Alberta. Since 1911 the pale western cutworm has been a crop pest of first importance, and yet before the introduction of farm cultural practices it was doubtless confined to wild plants. In this respect many injurious species of cutworms were indigenous and fed upon wild plants before the advent of our Aryan civilization.

Many of the insects now attacking fruit trees are known to have been originally confined to wild plants, and in this connection it may be of interest to note that Mr. Norman Criddle, of Treesbank, Manitoba, during the past summer (1924) found that a species of borer closely allied to *Saperda candida* Fab., which normally occurred on saskatoon (*Amelanchier* sp.) in Manitoba had spread from the latter to cultivated fruit trees and was attacking apple trees at Pilot Mound.

Certain important aspects of the relation of phytophagous insects to their food plants have been surprisingly neglected in the past. Craighead (1921), states that "very few references to the adaptation of insects to their host plants or the variation in their selection of host plants can be found." Brues (1923) writing on the "Choice of Food and Numerical Abundance among Insects," noted that, "In spite of its basic importance in determining the economic status of phytophagous insects, the remarkable instincts associated with the choice of food plants has been largely neglected as a field for investigation by economic entomologists."

Craighead, after carrying out a considerable series of host selection experiments with cerambycid beetles over a number of years, concluded that:

"In practically all the species experimented with the adults show a marked predilection for the host in which they fed as larvae, provided they are not deterred by other factors, such as the unfavourable condition or the small quantity of the host." He further concluded that "continued breeding in a given host intensifies the preference for that host."

At the instigation of the late Mr. R. C. Treherne* a study in the host-selection habits of the cabbage butterfly, *Pieris rapae* L., was incepted by the writer at Ottawa in 1923 and continued in 1924. The cabbage butterfly, which is an oligophagous species, feeds upon cultivated and wild plants belonging to four families, namely, *Cruciferae*, *Resedaceae*, *Capparidaceae* and *Tropaeolaceae*, among which it exhibits decided preferences. Of the cultivated plants cabbage is the most preferred, and this plant owing to its peculiar properties, abundance and wide distribution is pre-eminently the most suitable food for this ubiquitous species. In the early spring, however, owing to the absence of favoured cultivated plants it is necessary for the insect to search for other sources of food, and as the spring imagos are few in number the needs of their progeny are amply supplied by several species of common and widely distributed cruciferous weeds. This adaptability of the species to different, but related food plants, from season to season, assures the race a continuous and abundant food supply

*Obit., June 7, 1924.

throughout the growing period of the year, and in almost every region inhabited by man. This habit of the early spring butterflies of ovipositing on certain weeds has frequently caused comment and conjecture as to whether the females choose the weeds in preference to cultivated cruciferae or owing to necessity because of the scarcity of the latter. That the spring brood of butterflies have no particular preference for cruciferous weeds was clearly shown at Ottawa early in June, 1923. Several cultivated food plants of the cabbage butterfly together with three species of cruciferous weeds were grown in flower pots under glass prior to the emergence of the earliest butterflies. At the end of May, butterflies from overwintering pupae commenced emerging, and a number of both sexes were enclosed in a large cheesecloth lined cage, 8 feet long, 4 feet wide, and 6 feet high, reinforced with chicken wire, in which the various plants had been placed.

A careful egg count made some days later revealed that the cultivated plants consisting of cabbage, radish, nasturtium, tropaeolum, mignonette and alyssum, received 99.58 per cent. of the total of 1,436 eggs deposited, whereas, the cruciferous weeds which included hare's-ear mustard, ball mustard and false-flax, only received .42 per cent., confined solely to hare's-ear mustard. The ball mustard and false-flax plants which were completely ignored by the butterflies were larger than the hare's-ear mustard, but rather coarse and hairy, whereas the foliage of the latter is smooth and glossy. The order of preference for the five cultivated host plants as revealed by the average percentages of oviposition of butterflies of the spring and summer broods captured in the field, compiled from a total count of over 4,000 eggs, is as follows: cabbage, 56.48 per cent.; radish, 18.78 per cent.; nasturtium, 13.34 per cent.; mignonette, 8.52 per cent.; alyssum, 2.94 per cent. The oviposition records of the various "strains," mentioned later, revealed a similar order of preference with the exception that mignonette had precedence over nasturtium instead of vice versa.

In view of Craighead's conclusions mentioned in a previous page, it was thought that could the larvae of the cabbage butterfly be induced to feed on any one food plant for a considerable number of generations, the tendency of the females to oviposit on that plant would gradually increase and possibly result in the development of either monophagous or more restricted oligophagous habits. In order to secure experimental evidence in support of this, five food plants of the cabbage butterfly were selected for the main host-selection experiments, including cabbage, radish and alyssum, of the family *Cruciferae;* and nasturtium and mignonette of the families *Tropaeolaceae* and *Resedaceae* respectively. The procedure followed was to rear a number of cabbage butterfly larvae from the egg stage to maturity on each of these plants. The resultant pupae were then grouped according to the food plant on which they had been reared and placed in separate field cages described in an earlier paragraph. Each of these field cages contained a number of window boxes in which were growing a series of the five food plants on which the emerging females, after mating, were able to deposit their eggs freely. After a sufficient number of eggs had been deposited or the females showed signs of exhaustion, the butterflies were killed and preserved for later examination, careful egg counts were made for comparison, and the larvae resulting from these eggs reared on the same food plants on which the parents had been fed in the larval condition. By this means it was hoped that host-preference strains of butterflies could be developed on each of the plants and a thorough study made of the effect of such segregation upon the host-selection habits of the parents over several generations.

Unfortunately, owing to the activities of a prevalent and highly contagious

larval disease commonly known as "flacherie" this aim was not fully realized. This disease nullified our efforts over and over again by completely destroying whole series of experimental larvae despite all efforts to prevent it. Even larvae reared from the eggs in isolation from one another on apparently perfectly clean food frequently developed the disease. By repeated efforts, however, a number of individuals were successfully reared for one complete generation on cabbage, radish, mignonette and nasturtium. Alyssum had to be abandoned as it proved to be little favoured by the insect, the larvae finding great difficulty in establishing themselves on the very small and rather tough leaves, the consequent high rate of mortality in the early instars making it practically impossible to rear disease-free larvae to maturity under experimental conditions. The egg counts from each of the strains indicating the percentage on each plant are presented in tabular form below. The percentage of eggs deposited by any one strain on the food plant on which it was reared in the larval stage is underlined for the sake of emphasis.

OVIPOSITION RECORDS FROM CABBAGE BUTTERFLIES REARED ON DIFFERENT HOST PLANTS FOR ONE GENERATION—1923

Host	Cabbage Strain	Radish Strain	Mignonette Strain	Nasturtium Strain
Cabbage	73.88%	69.35%	63.63%	69.86%
Radish	17.95%	19.13%	3.20	19.00%
Mignonette	7.73%	11.30%	33.07%	10.15%
Nasturtium	.34%	.20%	.00%	.83%
Total eggs	2,963	1,035	121	1,211

A brief perusal of the above table will reveal that with each strain the percentages of eggs deposited on the various host plants is highest in the case of the species of plant on which the individuals of that strain were reared in the larval condition.

As only one generation of larvae was successfully reared to maturity on each of the food plants these results are not by any means conclusive. They seem to indicate, however, that the larval food does influence the selective tendencies of the imago. An increased preference exhibited by the parents for the host plant on which they were reared is apparent in practically every case. This increased preference is nowhere very great and only becomes noticeable when comparing the oviposition records of the different strains on any one food plant. The fact that the larvae have been reared on nasturtium for instance, apparently does not greatly influence the resulting butterflies' predilection for cabbage, but there is, however, a slight increase in the preference shown for the former plant.

In 1924, the experiments were repeated, this time using only cabbage, mignonette and nasturtium. The butterflies were very scarce in the field early in the season and only a limited number could be secured for the experiments, all overwintering material from 1923 having died before spring. The larvae were reared in sealers inside the insectary on clean, uninfested food frequently renewed, and individuals revealing symptoms of disease were quickly removed. Although, as in 1923, butterflies were successfully reared on each of the food plants for one generation, only a few of each were secured for oviposition records and owing to the increasing prevalence and virulence of the larval disease as the season advanced, the offspring of these individuals all died before reaching maturity.

Oviposition Records from Cabbage Butterflies Reared on Different Host Plants for One Generation—1924

Host	Cabbage Strain	Mignonette Strain	Nasturtium Strain
Cabbage	52.5%	22.5%	57.8%
Mignonette	46.3	53.1%	17.3%
Nasturtium	1.2%	24.4%	24.9%
Total eggs	132	98	1,226

The oviposition records of these butterflies show considerable variation from those secured from the individuals reared in 1923. This is particularly noticeable in the lower percentages of oviposition on cabbage with a consequent increase in the percentages on mignonette and nasturtium. This variation is possibly due to a number of factors, among which may be mentioned the elimination of radish from the experiments, the smaller number of individuals involved, and the somewhat unthrifty condition of the cabbage plants exposed to the ovipositing females due to transplanting and aphid injury. Under these conditions it is impossible to draw any definite conclusions from the results obtained in 1924 beyond indicating that there is a slightly higher percentage of oviposition on mignonette and nasturium where these plants were used as larval food. As in 1923, however, these oviposition records reveal, in general, an order of preference for the different plant families as follows: *Cruciferae*, *Resedaceae* and *Tropaeolaceae*.

An examination of the cabbage butterflies reared on the various host plants revealed no noticeable differences in size, colour, markings or structure other than variations that commonly occur in the species. The wing expanse of either sex frequently varies by one or two millimeters, and although the females are usually larger than the males, the latter are sometimes found somewhat larger than the former.

Cabbage butterflies not only reveal decided preferences in selecting food plants for their larval offspring, but also in choosing flowers from which to secure nectar for their own sustenance. That flowers are necessary for the continued existence of the imagos was frequently demonstrated in the field cages at Ottawa where it was found that during hot weather the butterflies succumbed in a few hours when suitable flowers were not provided. Folsom (1922) states that white butterflies belonging to the genus *Pieris* prefer white flowers, but this is not true in the case of *Pieris rapae* which reveals marked preferences for the yellow blossoms of the dandelion and field pansy, *Viola arvensis* Murray, in the spring, for the blue flowers of wild vetch in the early summer, and for the flowers of red sweet clover later in the season. Several white-flowered species are also visited, but with the exception of cultivated radish they are less sought after than the flowers already mentioned.

Of the senses which enable insects to exhibit such remarkable accuracy and consistency in selecting food plants for themselves and their offspring, probably the sense of smell plays the most important part. In this connection Brues (1920) states that "there is much in the behaviour of certain (lepidopterous) species to suggest that food plants are selected on the basis of odour by the female parent and also accepted on the same basis by the larvae." This is borne out by the known responses of insects to the odours emanating from attractants and repellants used in the control of many species. The Russian entomologist,

Vostrikov (1915), found the odour of solanaceous plants useful as a repellant when planted with other crops. Under the caption "Tomatoes as Insecticides: The Importance of *Solanaceae* in the Control of Pests of Agriculture," he noted that in the Province of Terek, Russia, cabbages are never attacked by *Pieris rapae* and certain other insects, when planted with tomatoes, a practice which is customary in that region. This is not true, however, under Ontario conditions, as was proved at Ottawa in 1924. Tomatoes planted so close to cabbages that the stems and leaves of the former intertwined with those of the latter failed to give the cabbages any protection from the cabbage worm whatsoever, and they became as badly infested as any planted elsewhere in the experimental plots.

List of References

Brues, C. T. (1920), "The Selection of Food Plants by Insects with Special Reference to Lepidopterous Larvæ," American Naturalist, Vol. 54, pp. 213-322.

Brues, C. T. (1923), "Choice of Food and Numerical Abundance among Insects, J. Ec. Ent., Vol. 16, pp. 46-51.

Craighead, F. C. (1921), "Hopkins' Host Selection Principal as Related to Certain Ceramycid Beetles," J. Agr. Res., Vol. 22, No. 4, pp. 189-220.

Folsom, J. S. (1922), "Entomology with Reference to its Biological and Economic Aspects," 3rd Edit., p. 100.

Gibson, A. (1915), "Cutworms and their Control," Can. Dept. Agr., Ent. Br., B 10, 30.

Walsh, B. D. (1864), "On Phytophagic Varieties and Phytophagic Species," Proc. Ent. Soc., Philadelphia, Vol. 3, pp. 403-430.

Walsh, B. D. (1865), "On Phytophagic Varieties and Phytophagic Species with Remarks on the Unity of Colouration in Insects," Ibid, Vol. 5, pp. 194-216.

Walsh, B. D. (1867), "The Colorado Potato-bug," Prac. Ent., Vol. 5, 2, pp. 116.

Vostrikov, P. (1915), Rev. App. Ent., Series A, Vol. 3, p. 340.

MISCELLANEOUS NOTES ON THE PEAR PSYLLA PROBLEM

William A. Ross, Dominion Entomological Laboratory, Vineland Station, Ontario

Ontario orchardists, who have had any real experience in combating the Pear Psylla, are unanimously of the opinion that this pest is infinitely more difficult to control than any other fruit insect with which they have to contend. In years favourable for the insect, such as the past season, the majority of fruit growers, with pear orchards subject to psylla attack, fail to prevent serious injury to their trees and fruit, and some of them are becoming so discouraged that they are threatening to take out their pear trees. What does this mean? Does it mean that, in spite of all the research work done by entomologists, the pear psylla problem is still unsolved? Decidedly no! It is true that with our present methods of control the psylla cannot be reduced under all conditions to absolute insignificance, but it can be reduced to such an extent that there will be no appreciable loss. In this paper we propose to discuss briefly some of the measures by means of which commercial control can be secured.

Horticultural Aspects of Control

Before taking up the matter of spraying, we wish to refer to what may be termed the horticultural aspects of control. We have observed that the psylla is primarily a pest of large orchards, and that it is of comparatively little importance in small plantings, unless they are sheltered by tall hedges or by large trees. We have observed that the insect multiplies most rapidly where the pears are thickly planted; where the wood growth on the trees is dense, and

where the orchards are protected by windbreaks. In other words, our observations indicate that the psylla thrives to best advantage under sheltered, still conditions, and conversely that good air drainage in and around the trees is more or less inimical to the insect. It therefore follows that those factors which have a bearing on orchard air drainage have at the same time an important bearing on psylla control. What are those factors? We should say the most important are (1) the orchard site; (2) distance of plant; (3) pruning practices; (4) windbreaks.

The Orchard Site: Wherever possible the pear orchard should be planted on sloping land with no deep hollows in it, and again, if possible, the trees should not be set out in the immediate neighbourhood of tall hedges or of large low-headed trees.

Distance of Planting: Very often a grower has little or no choice in deciding on a site for the orchard, but he always has control over the next factor, namely, distance of planting. The trees should be planted the maximum distance apart, that is, not closer than 25 feet by 18 feet. The conditions afforded by closely planted trees are undoubtedly highly favourable for the multiplication of psylla. Frequently our attention has been directed to the fact that it is in very closely planted orchards that the psylla "comes back" most quickly.

Pruning Practices: Concerning the next factor—pruning—we are decidedly of the opinion that good pruning*—which we should imagine would be very moderate annual pruning—which produces trees not too high and with properly spaced branches, not only makes conditions less favourable for the insect, but it also simplifies spraying by making it easier to thoroughly coat all parts of the trees with spray mixtures.

Windbreaks: And now a word about windbreaks. Windbreaks undoubtedly make conditions particularly favourable for pear psylla. One of the worst infested orchards in the Burlington district is a small planting of Bartletts and Keiffers, protected by a tall spruce hedge. I am satisfied that if this hedge were cut down, the insect would be, as it generally is in small plantings, of very little importance. I am not at all in favour of growing pear trees and windbreaks together.

Spraying

Various spray materials, directed against the eggs and nymphs or against the overwintering adults, have been used and are being used for the control of Pear Psylla—among others, lime sulphur, nicotine sulphate, fish-oil soap and various oil sprays.

Egg and Nymph Sprays: Lime sulphur as an egg spray and nicotine sulphate as a nymph spray have been used more in Ontario than anything else, and in the

*Mr. J. A. Neilson, of the Horticultural Experiment Station, Vineland Station, Ontario, has kindly prepared the following outline of the method of training pear trees on the open centre or vase plan:

"In starting an open centre tree, one year whips are headed back to a height of 24 to 30 inches at planting time. As result of this heading back several shoots will likely grow on the upper part of the trunk. The following spring from three to five of the best of these should be selected to form the main framework and all others removed. When choosing the foundation branches, select those that are evenly placed around the circumference of the tree and well spaced along the vertical axis. Where these leader branches have made a vigorous growth, they should be headed back moderately, but if a short growth has been made little heading back is needed. In any case the tops of these branches should preferably be left at about the same height. In the second season numerous laterals will likely develop on the leader branches. Two of the best of the side laterals should be selected as secondary branches and the rest removed. After a good foundation has been formed, it will only be necessary to cut out the least valuable of crowding branches and those that tend to fill up the centre. Where it is necessary to cut leader branches, it is advisable to cut just above an outward growing lateral in order to keep the centre open."

average season these two materials applied according to the following schedule will prevent any serious injury:

(1) Shortly before the trees bloom—commercial lime sulphur four gallons, hydrated lime five pounds, water forty gallons.

(2) After the blossoms fall—nicotine sulphate, half pint in forty gallons of weak bordeaux (1.10.40).

In the past we made a practice of spraying with lime sulphur 1-40 and nicotine after the blossoms, however, as lime sulphur at this time has in some orchards and in some seasons caused rather severe leaf injury, we have come to the conclusion that it would be advisable to substitute a weak bordeaux mixture (1-10-40) or wettable sulphur for it. The two applications referred to above will give commercial control in most orchards in the average season, but in years of severe outbreaks or in orchards where conditions are especially favourable for the insect, it may be and usually is necessary to apply an extra spray in July, at the time when most of the insects are so-called soft-shell nymphs (1st, 2nd, and 3rd instars). For this extra application nicotine sulphate half pint, lime 10 pounds; water forty gallons may be used.

Spraying for Winter Adults: Spraying pear trees in the fall for the purpose of destroying the winter "flies" is frequently recommended, but, as many of the adult psyllas may be present on other trees—fruit and shade—at this time, we question very much if fall spraying is as effective as spraying in late March or early April. The logical time to make the application appears to us to be just before the adults commence egg-laying. Spraying at this time with a commercial miscible oil, Scalecide, has been done to a limited extent in Ontario, and, in the case of the orchards which have come under our observation, good results have been secured. Scalecide, however, as we have been informed time after time by fruitgrowers, is much too costly, and in fact the same criticism has been levelled against the previously mentioned lime sulphur and nicotine spray schedule. For this reason we are now investigating the possibility of using cheap, home-made lubricating oil emulsions for psylla control. This work was commenced during the past year. In early April a thirteen-acre pear orchard was divided into six blocks and the blocks were sprayed just before egg-laying commenced with the following materials:

Block 1: Two per cent. soap-oil emulsion spray prepared according to the following formula:

Sterling red paraffin oil	2 gallons
Soft water	1 gallon
Fish-oil soap	2 pounds

This amount of emulsion was diluted in ninety-seven gallons of water.

Block 2: Two per cent. Kayso-oil emulsion spray prepared according to the following formula:

Sterling red paraffin oil	2 gallons
Soft water	1 gallon
Kayso (Calcium caseinate)	4 ounces

This amount of emulsion was diluted in ninety-seven gallons of water.

Block 3: Three per cent. Bordeaux-oil emulsion spray prepared according to the following formula:

Sterling red paraffin oil	3 gallons
Soft water	1½ gallons
Copper sulphate	⅜ pounds
Lime	⅜ pounds

This amount of emulsion was diluted in ninety-five and a half gallons of water.

Block 4:

2 per cent. Bordeaux-oil emulsion spray.

Block 6:

Lime sulphur	10 gallons
Hydrated lime	10 pounds
Nicotine sulphate	1 pint
Water	90 gallons

Check: This consisted of a small block which adjoins the main orchard. The trees in this block are not so subject to serious injury as those in the main orchard.

Results: Several careful inspections of the orchard made at various times after the sprays were applied showed that, while all the mixtures had destroyed a high percentage of the adults, the 3 per cent. oil spray had been outstandingly the most effective. About one week before the blossoms fell a thorough examination of leaf and blossom clusters in all parts of the orchard gave us the following data:

Block 1:

Nymph population per 1,000 blossom and leaf clusters....... =1,485*

The results in this block were very patchy, probably due in part to the breaking down of the emulsion in one tank.

Block 2:

Nymph population per 1,000 blossom and leaf clusters....... =203*

Results not uniform.

Block 3:

Nymph population per 1,000 blossom and leaf clusters....... =14

The results were uniformly excellent throughout this block.

Block 4:

Nymph population per 1,000 blossom and leaf clusters....... =448*

Results not uniform.

Block 6:

Nymph population per 1,000 blossom and leaf clusters....... =786*

Results not uniform.

Check:

Nymph population per 1,000 blossom and leaf clusters....... =10,371

The 3 per cent. spray gave excellent, clean-cut and remarkably uniform results. On the other hand the 2 per cent. oil sprays and the nicotine gave unsatisfactory and very patchy results, and for this reason blocks 1, 2, 4 and 6 along with the check were thoroughly sprayed after the blossoms with nicotine sulphate, half pint in forty gallons of weak bordeaux, but block 3 received no further psylla sprays.

The following notes made on September 3rd describe conditions in the experimental orchard at the time Bartlett pears were being picked:

"Block 3: Practically no leaf spotting; psylla very scarce; still freer from psylla than any other part of orchard."

"Blocks 1, 2 and 4: Psylla scarce; very little leaf spotting."

"Block 6: Psylla common but not present in injurious numbers."

"Check (sprayed once with nicotine): Psylla more abundant than in main orchard; considerable leaf spotting on inside trees. (We know from past experience that the check is not so subject to heavy psylla infestations as the

*Because of the unevenness of the nymph infestation in 1, 2, 4 and 6, these figures probably do not represent average conditions. Be that as it may, the main thing is that the results in blocks 1, 2, 4 and 6 were not satisfactory.

main orchard. In all probability, if the check had been in the main orchard, one post-blossom application of nicotine would not have prevented severe injury.")

Several pear growers who inspected the experimental orchard were very much impressed with the fact that one application of a 3 per cent. lubricating oil spray gave perfect control in a season favourable for psylla, and they immediately jumped to the conclusion that this same treatment could be depended on under all conditions to give similar results. However, we cannot afford to be so optimistic until more extensive experiments have been conducted under various conditions.

Importance of Thorough Spraying: In the control of the pear psylla, the necessity for very thorough spraying cannot be too strongly emphasized. Many growers undoubtedly fail to combat the insect successfully because they do not take sufficient care to thoroughly wet all parts of the tree with the spray material. In order to do thorough work, it is essential to use not less than 200 pounds pressure; to use some system in spraying the trees; and to use a liberal quantity of spray material—too much rather than too little.

INSECTS OF THE SEASON

W. A. Ross, Entomological Laboratory, Vineland Station

and

L. Caesar, Provincial Entomologist, O. A. C., Guelph

Orchard Insects

Codling Moth (*Cydia pomonella*). On the whole, this insect was less destructive than last year. In orchards east of Toronto sideworms did considerable damage, yet not so much as in 1923. In the Niagara district the second brood was very small. It may be of interest to mention that *Ascogaster carpocapsae* Viereck was bred from parasitized larvae at Vineland. This codling moth parasite has not been recorded from Canada heretofore.

Canker Worms (*Paleacrita vernata* and *Alsophila pometaria*). Neglected apple orchards in parts of Welland, Wentworth, Norfolk, Huron and Brant counties were defoliated by canker worms this spring.

Apple Aphids (*Aphis pomi* and *Anuraphis roseus*). These two species of aphids have seldom been more injurious in Ontario than this year, the weather having been exceptionally favourable for their development. Early in the season they were not unusually abundant but by the end of June both species had increased remarkably and they continued to be abundant until the end of August or early in September.

Generally speaking the rosy aphis was of importance only in old orchards while the green apple aphis infested trees of all ages. It was not an uncommon sight, particularly on Wagener apples, to see the fruit literally covered with the latter species. A considerable percentage of fruit throughout the province was badly deformed and dwarfed and rendered useless by the combined work of the two species.

San José Scale (*Aspidiotus perniciosus*). Throughout the Niagara district and, also so far as observed, in other parts of the province wherever the scale occurs, there has been a decided reduction in numbers this year. The

causes of this have not been determined. There is no doubt the exceptionally cool, wet season was one cause, possibly ice storms in the winter another, and in some places parasites played a considerable part.

APPLE MAGGOT (*Rhagoletis pomonella*). Specimens of apples infested by the maggots of this fruit fly were sent in from Lindsay, Greenwood, Norwich, Port Perry and Picton. At Greenwood the owner of the orchard stated he had not had an apple fit to eat for the last three years because of this insect.

ROUND-HEADED APPLE-TREE BORER (*Saperda candida*). It is only seldom that we have reports of severe injury from this borer in Ontario, hence it seems worth recording that several orchards in the southern part of Norfolk were much injured by it this year.

RED BUG (*Lygidea mendax*) and OTHER LEAF BUGS. As usual there was some injury this year in a number of orchards from one or other of these Mirids, but the injury seemed to have been less common and less severe than during the last few years.

YELLOW OR DUSKY TUSSOCK MOTH (*Halisidota tesselaris*). It will be remembered that last year there was a very unusual outbreak of the larvae of this species which did a great deal of damage in the latter part of the season to apple orchards over much of western Ontario. This year so many moths were taken at nights from near the end of June to the 8th or 9th of July that we were much afraid of a repetition of last year's outbreak. We were pleasantly surprised therefore to find only a moderate number of caterpillars this fall.

BARK MINER OF APPLE (*Marmara elotella*). The serpentine mines of this interesting insect were unusually conspicuous on the young wood of apple trees along the shore of Lake Ontario from Toronto to the Niagara River. The larvae mine in the epidermal layer of the bark but apparently do not in any way affect the health of the tree.

It may be of interest to state here that a closely related species, *M. pomonella* Busck, is occasionally found in Ontario making serpentine or blotched mines in the skin of apples. The larvae work between the epidermal and cuticular layers of the fruit.

EUROPEAN RED MITE (*Paratetranychus pilosus*). In the early part of the season this mite was not much in evidence but in August and September European plum foliage became heavily infested and at the present time the red eggs of the mite are to be seen in great numbers on the branches of plums and in some cases of apples.

PEAR PSYLLA (*Psyllia pyricola*). This insect was again very abundant and injurious in the Niagara and Burlington districts.

CHERRY FRUIT-FLIES (*Rhagoletis cingulata* and *R. fausta*). Owing to many growers having neglected to spray for the fruit-flies in recent years these insects have once more come into prominence in sour cherry orchards, especially in the Niagara and Burlington districts. In Waterford very severely infested cherry trees were found. This is apparently the first record of the occurrence of fruit-flies of cherry in that part of Norfolk county.

PEAR SLUG (*Caliroa cerasi*). The only part of the province where this insect was much in evidence was in Essex and Kent where many cherry trees were partially or completely defoliated by it.

BLACK CHERRY APHIS (*Myzus cerasi*). Unsprayed or poorly sprayed sweet cherry trees in the Niagara district were heavily infested with this plant louse. It was also sufficiently abundant on sour cherries not only in Niagara but in many other places to cause some alarm to fruit growers.

PLANT BUGS INJURIOUS TO PEACHES. Peaches grown in the immediate

vicinity of oak and hickory trees were again seriously injured by the three species of plant bugs to which we have referred in previous reports. This year the hickory species (*Lygus caryae*) was more prevalent and destructive than the oak species.

Grape and Small Fruit Insects

Rose Chafer (*Macrodactylus subspinosus*). This beetle again appeared in alarming numbers in many sandy sections of southern Ontario and attacked grapes, fruit trees and ornamentals.

Grape Leaf Hoppers (*Erythroneura comes* and *E. tricincta*). The outbreak of leaf hoppers in the Niagara Peninsula appears to be over, this year there being little or no severe hopper injury.

Grape Berry Moth (*Polychrosis viteana*). This grape insect has come into prominence as a serious pest in several vineyards between St. Catharines and Virgil.

Grape Blossom Midge (*Contarinia johnsoni*). Blossom buds infested with the whitish or yellowish larvae of this midge were observed in many vineyards this spring between the Niagara River and Fruitland. In no case, however, did we find the injury serious. Infested blossom buds are two or three times normal size and are either yellowish green in colour or sometimes partly reddish.

Grapevine Flea-Beetle (*Altica chalybea*). During June and July the grubs of this beetle were unusually abundant in Niagara vineyards. In many cases they skeletonized the leaves to a sufficient extent to attract attention. It seems probable that there will be an outbreak of this flea beetle next spring, particularly in vineyards along the foot of the escarpment or bordering upon woods.

Blackberry Leaf Miner (*Metallus bethunei*). This troublesome insect has been brought under control by natural factors and did but little damage this year.

Strawberry Weevil (*Anthonomus signatus*). Generally speaking this weevil was of little importance in Ontario this year. Among the few places where it did noticeable damage was Gravenhurst.

Currant Aphids (*Myzus ribis* and *Amphorophora lactucae*). Like the apple and some other species of aphids the currant aphids were exceptionally abundant this year.

Currant Fruit Fly (*Epochra canadensis*). It is so rarely that this insect is reported from any part of Ontario that it seems worth while recording that specimens were received this year from Dryden near the centre of the Kenora district. The plot was reported to be badly infested.

Insects Attacking Vegetables

Cabbage Maggot (*Phorbia brassicae*). Very few complaints of injury by the maggot were received.

Onion Maggot (*Hylemyia antiqua*). Though injuries from the onion maggot were reported from East York, Aylmer, Severn Bridge and Peterboro the insect was, as far as can be judged, not so abundant as usual.

Cutworms. At Barrie, Alliston, Timmins, Severn Bridge, New Liskeard, Franklin, Birch Cliff and Listowel cutworms did considerably damage. All the species were not determined but one of the troublesome forms was the black army cutworm (*Agrotis fennica*) and another the white cutworm (*Lycophotia scandens*).

STALK BORER (*Papaipema nitela*). In many parts of southwestern Ontario this borer was quite common and attacked many kinds of stock plants. It was often mistaken by the growers for the European corn borer.

SPINACH LEAF MINER (*Pegomyia hyoscyami*). Spinach, beets, mangels and lamb's quarters were severely attacked by this miner in many parts of the province.

STRIPED CUCUMBER BEETLE (*Diabrotica vittata*). In southwestern Ontario this beetle occurred in larger numbers than last year but there was no conspicuous outbreak.

POTATO LEAF HOPPER (*Empoasca mali*). This leaf hopper was of little or no importance in southern Ontario potato fields.

SLUGS (*Agriolimax agrestis*). As one would expect in such a wet season slugs were very numerous and did considerable damage.

INSECTS ATTACKING FIELD CROPS AND GRASSES

WIREWORM (*Agriotes mancus*). What appeared to be this species was moderately common this year and specimens were received from the locality of Guelph, Port Arthur, Mitchell, Scarboro Junction and Exeter. At Vineland tomato plants were attacked by a stem boring species.

WHITE GRUBS (*Phyllophaga spp.*). There was about the usual number of complaints of damage from white grubs.

MISCELLANEOUS INSECTS

WALNUT CATERPILLAR (*Datana integerrima*). This caterpillar has appeared in great numbers for several years past. This year a large part of the walnut and butternut trees in the southwestern part of Ontario were either entirely or to a large extent defoliated by it.

SPINY OAKWORM (*Anisota senatoria*). Like the walnut caterpillar this oak pest which was abundant last fall was again abundant this year.

LILAC LEAF MINER (*Gracilaria syringella*). Last year we reported the presence of what appeared to be this species in several parts of Ontario. This year again it has been sent in from a number of places. In Guelph a lilac hedge about forty feet long was so severely infested that approximately 90 per cent. of the leaves had all the green surface devoured. The larvae seem to begin at the apex and gradually roll the leaf down, feeding under the cover of the roll. Anywhere from one to thirty larvae were to be found on a leaf. Most infested leaves sent in from other places showed injury only in the form of large blotched mines and there was no indication of the rolling which took place in Guelph. It would not be surprising if we were to have a good deal of trouble from this pest during the next few years. At Guelph the larvae were mature and had entered the soil in large numbers for pupation by June 28th and by July 21st the majority of the moths had emerged.

BALTIMORE BUTTERFLY (*Euphydryas phaeton*). Numerous larvae of this butterfly were found on Turtle-head (*Chelone glabra*). Nearly all the adults from these had emerged by July 21st. In the collections of the summer school teachers this butterfly was quite common, this showing that it was far more abundant this year than usual.

COSMOPOLITE BUTTERFLY (*Vanessa cardui*). Throughout the southwestern part of Ontario the larvae were very common and farmers reported them as feeding on Canada Thistle greedily. There was some alarm felt by them in a few instances lest the larvae might attack grain crops.

SPRUCE MITE (*Paratetranychus ununguis*). In a nursery at Winona blue spruce and balsam fir were injured by this mite.

TERRAPIN SCALE (*Eulecanium nigrofasciatum*). According to a report received last spring from the superintendent of parks, St. Catharines, many of the soft maples in that city were heavily infested with this scale.

WHITE FLIES (*Trialeurodes vaporariorum*). Each year this troublesome insect seems to be growing more and more abundant, especially in private homes.

CARPET BEETLES (*Anthrenus scrophulariae* and *Attagenus piceus*). A very large number of housewives requested information on how to combat this household insect.

CLOTHES MOTH (*Tinea biselliella*). Requests for information on control measures were received from every side.

HOUSEFLY (*Musca domestica*). In southern Ontario the housefly was less abundant this fall than usual.

THE ENTOMOLOGICAL RECORD, 1924

NORMAN CRIDDLE, ENTOMOLOGICAL BRANCH, DOMINION DEPARTMENT OF AGRICULTURE

The amount of material available for inclusion in the "Record" is now so great that we are obliged to make some alterations in the usual procedure. As a beginning, in order to utilize space to the best advantage, we are taking it for granted that every working entomologist reads the "Canadian Entomologist" and in consequence new species published in that journal will no longer be listed. We have also been obliged to reduce zonal records to one or two for each province.

One of the objects in preparing an "Entomological Record" has been to gradually map out the distribution of Canadian insects, an accomplishment which would be of marked value both to the economic and systematic worker. Much progress has been recently made towards this object and we are now in a position to provide fairly complete lists in certain families. As an alternative to publishing all promiscuous records, we have thought, therefore, that our readers might be more interested in complete group lists, and with that idea in view, we are providing annotated lists of the Canadian Eucosminae and Ephemeridae. This will bring the known distribution up-to-date and thus provide a simple means of detecting new records after the species have been determined.

We are again indebted to specialists in the United States and Great Britain for assistance in determining certain species.

NOTES OF CAPTURES

Species preceded by an asterisk (*) described since the last Record was prepared.

LEPIDOPTERA

(Arranged according to Barnes and McDunnough's Check List of the Lepidoptera.)

Lycaenidae
413 *Heodes rubidus* Behr. Milk River, Alta., (R. D. Bird).

Sphingidae
733 *Haemorrhagia gracilis* Grt. Victoria Beach, Man., (H. Brodie).

Noctuidæ
* *Porosogrotis vetusta mutata* B. & Benj. Kaslo, Arrowhead Lake, and Vernon, B.C.
* *Anarta poca* B. & Benj. Pocahontas, Alta., (Mrs. Mitchall).
* *Anarta lagganata* B. & Benj. Laggan, Alta., (F. H. Wolley-Dod).
* *Lasionycta alberta* B. & Benj. Nordegg, Alta., (J. McDunnough).
* *Perigrapha praeses stigmata* B. & Benj. Duncan and Wellington, B.C., (W. H. Hanham).
* *Oncocnemis mackiei* B. & Benj. Edmonton, Alta., (D. Mackie and K. Bowman).
The above six insects described in Cont. Nat. Hist. Lep., Vol. V, Nos. 2 and 3.
2135 *Graptolitha oriunda* Grt. Lobo, Ont., (A. E. Wood).
2206 *Epiglaea decliva* Grt. Lobo, Ont., (Wood).
2332 *Oligia violacea* Grt. Penticton, B.C., (Paul Vroom).
* *Eremobia hanhami* B. & Benj. Duncan, B.C., (A. W. Hanham).
* *Apatela fragilis fragiloides* B. & Benj. Duncan and Guamichan Lake, B.C., (Hanham).
* *Gortyna columbia* B. & Benj. Saanich, B.C., (Downes); Duncan, B.C., (Hanham).
* *Gortyna intermedia* B. & Benj. Ft. Calgary, N.W. B.C.
The above described in Cont. Nat. Hist. Lep., Vol. V, No. 3, 1924.
2171 *Stibadium spumosum* Grt. Lethbridge, Alta., (Seamans).
2769 *Plagiomimicus expallidus* Grt. Lethbridge, Alta., (Seamans).
* *Bellura obliquus pallida* B. & Benj. Edmonton, Alta., (D. Mackie).
Cont. Nat. Hist. Lep., Vol. V, 1924.
2667 *Papaipema furcata* Sm. Aweme, Man., (N. Criddle).

2844 *Annaphila danistica* Grt. Oliver, B.C., (Garrett).
3105 *Catocala mira* Grt. Strathroy, Ont., (W. H. Hudson).
3365 *Strenoloma lunilinea* Grt. Lobo, Ont., (Woods).

Notodontidae
3611 *Odontosia elegans* Stkr. Lethbridge, Alta., (Seamans).
3625 *Dasylophia anguina* A. & S. Lethbridge, Alta., (Seamans).
3671a *Cerura cinerea cinereoidea* Dyar. Lethbridge, Alta., (Seamans).

Pyralidae
4997 *Evergestis vinctalis* B. & McD. Oliver, B.C., (Garrett).
4999 *Evergestis obscuralis* B. & McD. Watertown Lake, Alta., (McDunnough); Kaslo, B.C., (Cockle).

Aegeriidae
6655 *Synanthedon exitiosa* Say. Douglas Lake, Man., (R. D. Bird).

The following species were collected by Dr. McDunnough at Waterton Lake, Alta., and determined by Miss Braun.

Cosmopterygidae
5990 *Cyphophora tricristatella* Cham.
6004 *Mompha albopalpella* Cham.

Gelechiidae
6044 *Aristotelia rubidella* Clem.
Telphusa praefixa Braun.
6110 *Gnorimoschema triocellella* Cham.
6112 *Gnorimoschema radiatella* Busck.
6191 *Anacampsis niveopulvella* Cham.
Gelechia metallica Braun.
Gelechia abradescens Braun.
Gelechia conspersa Braun.
Gelechia clandestina Meyr.
6211 *Gelechia continuella* Zell.
6362 *Trichotaphe purpureofusca* Walsingham.
6368 *Trichotaphe levisella* Fyles.

Oecophoridae
6503 *Borkhausenia haydenella* Cham.
6493 *Schiffermuelleria dimidiella* Wlsm.
Schiffermuelleria rostrigera Meyr.

Glyphipterygidae
Allononyma fabriciana var. *alpinella* Busck.
7618 *Choreutis onustana* Wlk.
7619 *Choreutis balsamorrhizella* Busck.
7621 *Choreutis occidentella* Dyar.

Plutellidae
7675 *Plutella porrectella* Linn.

Yponomeutidae
Argyresthia monochromella Busck.
7694 *Argyresthia pygmaeella* Hbn.
7695 *Argyresthia oreasella* Clem.
7703 *Argyresthia conjugella* Zell.

Coleophoridae
Coleophora crinita Braun.
7798 *Coleophora tenuis* Wlsm.

Elachistidae
Elachista aurocristata Braun.
Tinagma gigantea Braun.
Tinagma pulverilinea Braun.

Gracilariidae
8051 *Gracilaria murtfeldtella* Busck.

Scythridae
8082 *Scythris ochristriata* Wlsm.

Tineidae
8198 *Myrmecozela (Amydria) coloradella* Dietz.
8235 *Dietzia martinella* Wlk.

Incurvariidae

8438 *Chalceopla cockerelli* Busck.
Greya subalba Braun.
Lampronia piperatella Busck.
8431 *Lampronia aenescens* Wlsm.
8432 *Lampronia politella* Wlsm.
Lampronia obscuromaculata Braun.
Lampronia variata Braun.

OLETHREUTIDAE

Eucosminae (prepared by J. McDunnough)

The following list of Canadian Eucosminae has been made as complete as possible, and is the result of work carried on during the past two years, based on Heinrich's Monograph of this subfamily (Bull. 123, U.S.N.M.) and the material in the Canadian National Collection.

Pseudogalleria inimicella Zell. Aweme, Man. (N. Criddle).
Petrova albicapitana Bsk. Prince Albert, Sask.
Petrova picicolana Dyar. Massett, B.C.
Petrova burkeana Kft. Nordegg, Alta., (J. McDunnough).
Barbara colfaxiana var. *taxifoliella* Bsk. Waterton Park, Alta. (C. H. Young; Agassiz, B.C., (R. Glendenning).
Spilonota ocellana D. & S. Annapolis, N.S.; Ottawa, Trenton, Ont., (J. Evans); Vernon, B.C., (E. P. Venables).
Thiodia radiatana Wlshm. Digby, N.S., (J. Russell); Montreal, Que.
* *Thiodia albertana* McD. Lethbridge, Alta., (H. L. Seamans).
Thiodia essexana Kft. Montreal, Que.; Trenton, Ont., (Evans).
Thiodia awemeana Kft. Aylmer, Que., (McDunnough); Ottawa, Ont., (Young), Aweme, Man., (Criddle).
* *Thiodia indeterminana* McD. Aylmer, Que., (McDunnough); Ottawa, Ont., (Young); Edmonton, Wabamun, Waterton Park, Rocky Mt. House, Alta; Cranbrook, B.C., (C. Garrett); Salmon Arm, B.C., (W. R. Buckell).
Thiodia umbrastriana Kft. Aylmer, Que., (Curran and McDunnough); Meach Lake, Que., (Young).
Thiodia roseoterminana Kft. Meach Lake, Que., (Young); Aweme, Man., (Criddle). Saskatoon, Sask., (K.M. King).
Thiodia ferruginana Fern. Ottawa, Ont., (Young and McDunnough).
Thiodia formosana Clem. Digby, N.S., (Russell); Chelsea, Meach Lake, Aylmer, Que; (Young and McDunnough); Ottawa, Trenton, Ont., (Young, Evans); Calgary, Edmonton, Alta., (Bowman); Salmon Arm, B.C., (Buckell).
Thiodia ochroterminana Kft. St. Johns, Que., (G. Chagnon); Ottawa, Trenton, Ont.; Aweme, Man.
Thiodia perfuscana Heinr. Ottawa, (J. Fletcher); Trenton, Ont., (Evans).
Thiodia corculana Zell. Regina, Saskatoon, Sask., (King); Waterton Lakes, Alta., (McDunnough); Keremeos, B.C., (E. R. Buckell).
Thiodia amphorana Wlshm. Calgary, Alta., (Wolley-Dod).
Thiodia refusana Wlk. Aweme, Man.; Hedley, B.C., (Garrett).
Thiodia annetteana Kft. Reported by Kearfoot in the Ent. Record for 1907 from Cartwright, Man.
Thiodia columbiana Wlshm. Nicola, B.C., (Buckell).
Thiodia crispana Clem. Trenton, Ont., (Evans).
Thiodia marmontana Kearf. Aweme, Man., (Criddle); Saskatoon, Sask., (King); Nordegg, Waterton Park, Alta., (McDunnough).
Thiodia alternana Heinr. Aweme, Man., (Criddle).
Thiodia oregonensis Heinr. Waterton Park, Alta., (McDunnough).
* *Thiodia modernana* McD. Aylmer, Que., (McDunnough); Cranbrook, Salmon Arm, B.C., (Garrett, Buckell).
* *Thiodia convergana* McD. Aweme, Man., (Criddle).
Thiodia apacheana Wlshm. Reported from Kaslo, B.C., (Cockle) in the Kootenai list (Proc. U.S.N.M., XXVII, 926).
Thiodia influana Heinr. Aweme, Man., (Criddle); Lethbridge, Alta., (Seamans); Windermere, B.C., (Dod.)
Thiodia kokana Kearf. (*sororiana* Heinr.). Aweme, Man., (Criddle).
* *Thiodia complicana* McD. Osoyoos, B.C., (Garrett).
Thiodia ornatula Heinr. Aweme, Man., (Criddle).
Thiodia elongana Wlshm. Kaslo, B.C., (Cockle).
Thiodia transversa Wlshm. Kaslo, B.C., (Cockle).
* *Thiodia rupestrana* McD. Calgary, Nordegg, Laggan, Alta., (Dod, McDunnough, Bean).
Thiodia misturana Heinr. Aweme, Man., (Criddle); Regina, Sask.; Vernon, Hedley, B.C., (Buckell, Garrett).
Thiodia fertoriana Heinr. Aweme, Man., (Criddle); Regina, Lethbridge, Alta.; Nicola, B.C., (Buckell).

Thiodia indagatricana Heinr. Aweme, Man., (Criddle); Waterton Park, Alta., (McDunnough).
Thiodia spiculana Zell. Aweme, Man., (Criddle).
Thiodia striatana Clem. Meach Lake, Que.; Ottawa, Trenton, Ont., (Young, Evans); Aweme, Man., (Criddle); Moraine Lake, Alta., (McDunnough).
Thiodia dorsiatomana Kft. Westburn, Man., (Criddle); Saskatoon, Sask., (King); Lethbridge, Hillcrest, Alta., (Seamans, Bowman).
Thiodia kiscana Kft. Ottawa, Trenton, Ont., (Young, Evans).
Thiodia perangustana Wlshm. Keremos, B.C., (Garrett).
Thiodia pallidicostana Wlshm. Aweme, Man., (Criddle); Lethbridge, Alta., (Seamans).
Thiodia modicellana Heinr. Aweme, Man., (Criddle); Lethbridge, Waterton Park, (Seamans, McDunnough).
Thiodia infimbriana Dyar. Kaslo, Salmon Arm, Hedley, Vancouver, B.C.
Thiodia infimbriana var. *candidula* Heinr. Aweme, Man.; Nordegg, Alta., (McDunnough).
Thiodia octopunctana Wlshm. Treesbank, Man., (Criddle).
* *Thiodia youngi* McD. Waterton Park, Alta., (Young).
Thiodia festivana Heinr. Aweme, Man., (Criddle).
* *Thiodia camdenana* McD. Camden Bay, Alaska.
Thiodia montanana Wlshm. Aweme, Man., (Criddle).
Thiodia imbridana Fern. Aweme, Rownthwaite, Man., (Criddle, Marmont); Saskatoon Sask., (King).
Eucosma fandana Kft. Aweme, Man., (Criddle).
Eucosma ridingsana Rob. Aweme, Rownthwaite, Man., (Criddle, Marmont); Calgary, Banff, Alta.; Lillooet, B.C., (A. Phair).
Eucosma fernaldana Grt. Aweme, Man., (Criddle).
Eucosma argenteana Wlshm. Lethbridge, Alta., (Seamans).
Eucosma serpentana Wlshm. Lethbridge, Alta., (Strickland, Seamans).
* *Eucosma ophionana* McD. Lethbridge, Waterton, Nordegg, Alta., (Seamans, McDunnough).
Eucosma morrisoni Wlshm. Aweme, Man., (Criddle); Last Mt. Lake, Sask., (Young); Lethbridge, Waterton, Nordegg, Alta.; Chilcotin, Keremeos, B.C.
Eucosma heathiana Kft. Aweme, Man.
Eucosma argentialbana Wlshm. Aweme, Man.; Lethbridge, Waterton, Nordegg, Alta.
Eucosma pergandeana Fern. Trenton, Ont., (Evans); Aweme, Man.; Regina, Last Mt. Lake, Sask.; Lethbridge, Waterton, Nordegg, Hillcrest, Alta.; Kaslo, Osoyoos, Keremeos, B.C.
Eucosma agricolana Wlshm. Reported by Dyar from Kaslo, B.C. (1. c. 925).
Eucosma comatulana Zell. Aweme, Man., (Criddle).
Eucosma galenapunctana Kft. Lethbridge, Alta., (Seamans).
Eucosma serapicana Heinr. Lethbridge, Alta.
Eucosma scintillana Clem. Aweme, Rounthwaite, Man.
Eucosma scintillana var. *randana* Kft. Lethbridge, Alta., (Seamans).
Eucosma subflavana Wlshm. Lethbridge, Alta., (Seamans); Chilcotin, B.C., (Buckell).
Eucosma glomerana Wlshm. Aweme, Man.; Saskatoon, Sask.
Eucosma sandana Kft. Aweme, Man.
* *Eucosma vagana* McD. Aweme, Man.; Saskatoon, Sask.
Eucosma tocullionana Heinr. Ottawa, Ont., (Young).
Eucosma grotiana Kft. Aweme, Man.; Saskatoon, Sask.
Eucosma lolana Kft. Waterton Park, Moraine Lake, Alta., (McDunnough) Keremeos (Garrett), Aspen Grove, B.C., (P. Vroom).
Eucosma palabundana Heinr. Aweme, Man.
Eucosma occipitana Zell. Saskatoon, Sask., (King); Lethbridge, Nordegg, Alta., (Seamans, McDunnough).
* *Eucosma heinrichi* McD. Aweme, Man.
Eucosma bilineana Kft. Aweme, Man.; Lethbridge, Alta.
Eucosma mediostriata Wlshm. Lethbridge, Alta.
Eucosma nandana Kft. Described from Rounthwaite, Man. No specimens examined.
Eucosma landana Kft. Aweme, Man.; Craven, Sask., (Young); Calgary, Alta., (Dod.)
* *Eucosma simplex* McD. Calgary, Alta., (Dod).
Eucosma dorsisignatana Clem. Aweme, Man.; Regina, Sask.; Edmonton, Alta. (Bowman); Kaslo, B.C., (Cockle).
Eucosma similana Clem. Ottawa, Trenton, Ont.; Aweme, Man.
Eucosma graduatana Wlshm. Listed by Heinrich from Aweme, Man.
Eucosma juncticiliana Wlshm. Meach Lake, Que.; Ottawa, Trenton, Ont.; Aweme, Man.; Victoria, B.C., (W. Downes).
Eucosma excusabilis Heinr. Waterton Park, Alta., (J. McDunnough).
Eucosma sombreana Kft. Aweme, Man.
Eucosma fuscana Kft. Not yet determined. One of the type localities was Rounthwaite, Man.
Eucosma corosana Wlshm. Aweme, Man.; Saskatoon, Sask.; Calgary, Alta.
Eucosma hohana Kft. Moraine Lake, Alta., (McDunnough); Kaslo, B.C., (Cockle).

Eucosma pulveratana Wlshm. Aweme, Man.
Eucosma suadana Heinr. Aweme, Man.; Lethbridge, Alta.
Eucosma metariana Heinr. One of the type localities was Victoria, B.C., (Blackmore).
Eucosma rorana Kft. Aweme, Man.; Hedley, B.C., (Garrett).
Eucosma cataclystiana Wlk. Fredericton, N.B.; Kingsmere, Que.; Trenton, Ont.; Aweme, Man.; Regina, Sask.; Lethbridge, Waterton, Alta.
Eucosma resumptana Wlk. Described from Nova Scotia; not yet recognized.
Epiblema strenuana Wlk. Trenton, Ont., (Evans).
Epiblema scudderiana Clem. Meach Lake, Que., (Young); Ottawa, Trenton, Ont.
* *Epiblema benignata* McD. Aweme, Man.
Epiblema obfuscana Dyar. Montreal, Cascades, Que.
Epiblema carolinana Wlshm. Port Stanley, Ont., (Crawford); Cartwright, Man., (a/c Kearfott).
Epiblema hirsutana Kft. Reported by Kearfott (Ent. Rec. 1906), from Aweme, Man. Needs verification.
Epiblema periculosana Heinr. Waterton Park, Moraine Lake, Banff, Nordegg, Alta.; Salmon Arm, (Buckell); Keremeos, B.C., (Garrett).
Epiblema purpurissatana Heinr. Barrington Passage, N.S., (Young); Vernon, Victoria, B.C., (W. Downes).
Epiblema walsinghami Kft. Ottawa, Ont., (A. Gibson).
Epiblema suffusana Zell. Reported by Kearfott (Ent. Rec. 1906), from Regina, Sask.
Epiblema illotana Wlshm. Barrington Passage, N.S., (Young); Ottawa, Trenton; Aweme, Man.; Lethbridge, Waterton, Alta.
Epiblema culminana Wlshm. Waterton, Edmonton, Alta., (Bowman); Oliver, Vernon, Victoria, B.C.
Epiblema otiosana Clem. St. Johns, Que.; Trenton, Port Stanley, Ont., (Crawford).
Epiblema tandana Kft. Aweme, Man.
Epiblema abbreviatana Wlshm. Aylmer, Que., (McDunnough); Ottawa, Ont.; Aweme, Man.; Salmon Arm, B.C., (Buckell).
Gypsonoma fasciolana Clem. Barrington Passage, N.S.; Ottawa, Algonquin Park, Ont.; Aweme, Man.; Calgary, Nordegg, Alta.; Kaslo, B.C.
Gypsonoma nebulosana Pack. Hopedale, Labr.
Gypsonoma parryana Curtis. Barter Is., Camden Bay, Alaska.
Gypsonoma haimbachiana Kft. Trenton, Ont.
Gypsonoma substitutionis Heinr. Ottawa, Ont.; Aweme, Man.
Gypsonoma salicicolana Clem. Ottawa, Trenton, Ont.
Gypsonoma adjuncta Heinr. Trenton, Ont.; Aweme, Man.; Edmonton, Alta.
Proteoteras aesculana Riley. Trenton, Ont.
Proteoteras willingana Kft. Aweme, Man.; Saskatoon, Regina, Sask.
Proteoteras crescentana Kft. Regina, Sask.
Proteoteras moffatiana Fern. Meach Lake, Que.; Ottawa, Ont.
Proteoteras obnigrana Heinr. Ottawa, Ont., (Young).
Zeiraphera ratzeburgiana Sax. Chatham, Youghall, N.B.; Meach Lake, Que.; Ottawa, Ont.; Ucluelet, B.C., (Young).
Zeiraphera diniana Gn. Ottawa, Trenton, Ont.; Nordegg, Alta.
Zeiraphera fortunana Kft. Ottawa, Ont.
* *Zeiraphera vancouverana* McD. Ucluelet, B.C.
Exentera improbana Wlk. Meach Lake, Aylmer, Que.; Ottawa, Ont.
Exentera oregonana Wlshm. Aweme, Man.; Edmonton, Calgary, Alta.; Kaslo, B.C.
Exentera maracana Kft. (?) Ottawa, Ont. Our specimens may prove to belong to *perstructana* Wlk., a species unidentified by Heinrich; they match Walsingham's figure closely.
Exentera spoliana Clem. Aylmer, Que.; Ottawa, Ont.
Exentera senatrix Heinr. Cranbrook, B.C., (Garrett).
Gretchena watchungana Kft. Digby, N.S., (Russell); Aylmer, Que.; Ottawa, Ont.
Gretchena deludana Clem. Aylmer, Que., (McDunnough).
Gretchena amatana Heinr. Aylmer, Que.; Ottawa, Ont.
Griselda radicana Wlshm. Nordegg, Banff, Alta.; Duncan, B.C., (Day).
Norma dietziana Kft. Reported by Kearfott (Ent. Rec. 1912), from St. Johns, Que.
Kundrya finitima Heinr. Barrington Passage, N.S.; Ottawa, Ont., (Young).
Hendecaneura shawiana Kft. Ottawa, Ont., (Young).
Rhopobota geminana Steph. Ucluelet, B.C., (Young).
Rhopobota naevana Hbn. Victoria, B.C., (Downes).
Epinotia similana Hbn. Bridgetown, N.S.; Meach Lake, Que.; Ottawa, Trenton, Ont.; Aweme, Man.; Nordegg, Alta.; Nicola, B.C., (Vroom).
Epinotia solandriana Linn. Meach Lake, Que.; Ottawa, Ont.; Waterton Park, Alta., (McDunnough); Victoria, B.C., (Downes).
Epinotia pulsatillana Dyar. Kaslo, B.C., (Cockle).
Epinotia medioviridana Kft. Ottawa, Ont., (Young).
Epinotia castaneana Wlshm. Moraine Lake, Alta., (McDunnough); Kaslo, B.C., (Cockle).
Epinotia johnsonana Kft. Victoria, (Blackmore); Departure Bay, B.C., (Young).

Epinotia madderana Kft. Trenton, Ont.; Rounthwaite, Man., (Marmont).
Epinotia laracana Kft. Otatwa, Ont., (Young).
Epinotia hopkinsana Kft. Victoria, B.C., (Blackmore).
Epinotia solicitana Wlk. Barrington Passage, N.S.; Montreal, Megantic, Aylmer, Que.; Ottawa, Ont.; Kaslo, Vancouver, B.C.
* *Epinotia corylana* McD. Ottawa, Ont.
Epinotia rectiplicana Wlshm. Barrington Passage, N.S.; Gaspé, St. Johns, Que.; Agassiz, Hedley, Victoria, B.C.
Epinotia misella Cl. Ottawa, Ont.; Aweme, Man. (as *criddleana* Kft.); Banff, Edmonton, Red Deer, Nordegg, Alta., (Bowman); Oliver, B.C., (Garrett).
Epinotia albangulana Wlshm. Wellington, Vancouver, B.C.
Epinotia momonana Kft. Bridgetown, N.S.; Meach Lake, Que.; Ottawa, Ont.; Aweme, Man.
Epinotia transmissana Wlk. Ottawa, Trenton, Ont.; Salmon Arm, B.C., (Buckell).
Epinotia silvertoniensis Heinr. Waterton Park, Moraine Lake, Alta., (McDunnough).
Epinotia digitana Heinr. Banff, Moraine Lake, Alta.; Ucluelet, B.C.
Epinotia nigralbana Wlshm. Waterton Park, Moraine Lake, Alta.
* *Epinotia sagittana* McD. Departure Bay, B.C.
Epinotia emarginana Wlshm. Victoria, B.C.
Epinotia crenana Hbn. Nordegg, Alta.; Kaslo, Vancouver, B.C.
Epinotia bicordana Heinr. Aweme, Man.
Epinotia arctostaphylana Kft. Nordegg, Alta., (Bowman).
Epinotia timidella Clem. Aweme, Man.
Epinotia aceriella Clem. Aylmer, Que.; Trenton, Ont.
Epinotia nonana Kft. Lethbridge, Alta., (Seamans).
Epinotia normanana Kft. Aweme, Man.
Epinotia nanana Tr. Vancouver, B.C., (Glendenning).
Epinotia meritana Heinr. Victoria, B.C., (Carter); one of the type localities.
Epinotia medioplagata Wlshm. Ottawa, Trenton, Ont.; Waterton Park, Moraine Lake, Nordegg, Alta.
Epinotia plumbolineana Kft. Victoria, B.C., (Downes).
Epinotia lomonana Kft. Aweme, Man.; Edmonton, Alta., (Bowman); Salmon Arm, Victoria, B.C.
Epinotia cruciana Linn. Meach Lake, Que.; Ottawa, Ont.; Nordegg, Banff, Moraine Lake, Alta.; Kaslo, Salmon Arm, B.C.
Epinotia cruciana var. *alaskae* Heinr. Fort Wrigley, N.W.T., (Crickmay).
Epinotia cruciana var. *russata* Heinr. Described from Victoria, B.C.
Epinotia seorsa Heinr. Salmon Arm, Victoria, B.C.
Epinotia vagana Heinr. Kaslo, Victoria, Departure Bay, B.C.
Epinotia lindana Fern. Meach Lake, Que.; Ottawa, Ont.; Aweme, Man.
* *Epinotia kasloana* McD. Kaslo, B.C.
Epinotia signiferana Heinr. Kaslo, B.C.
Epinotia trossulana Wlshm. Reported by Heinrich from Victoria, B.C.
Anchylopera nubeculana Clem. Digby, N.S.; Meach Lake, Que.; Ottawa, Trenton, Ont.; Aweme, Man.; Red Deer, Waterton Park, Alta.
Anchylopera subaequana Zell. Barrington Passage, N.S.; Ottawa, Ont.
Anchylopera subaequana var. *kincaidana* Fern. Nordegg, Alta.; Ucluelet, B.C.
Anchylopera discigerana Wlk. Kaslo, Salmon Arm, B.C.
Anchylopera spireaefoliana Clem. Montreal, Que., (Winn); Ottawa, Ont.; Aweme, Man.
Anchylopera angulifasciana Zell. Ottawa, Trenton, Ont.; Nordegg, Alta.
Anchylopera burgessiana Zell. Ottawa, Ont.; Aweme, Rounthwaite, Man.
Anchylopera platanana Clem. Aylmer, Que.; Ottawa, Ont.
Anchylopera laciniana Zell. Ottawa, Ont.
Anchylopera fuscociliana Clem. Ottawa, Ont.
Ancylis comptana Froel. Barrington Passage, N.S.; Aylmer, Meach Lake, Que.; Ottawa, Ont.; Aweme, Man.; Lethbridge, Waterton Park, Alta.; Kaslo, B.C.
Ancylis cometana Wlshm. Aweme, Man.; Nordegg, Alta.
Ancylis divisana Wlk. Digby, N.S.; Ottawa, Ont.
Ancylis apicana Wlk. Barrington Passage, N.S.; Ottawa, Ont.
Ancylis muricana Wlshm. Aylmer, Que., (McDunnough); Grimsby, Ont.
Ancylis carbonana Heinr. Barrington Passage, N.S.; Ottawa, Ont.; Gaspé, Que.
Ancylis diminutana Haw. Ottawa, Trenton, Ont.; Aweme, Man.; Nordegg, Alta.; Vancouver, B.C.
Ancylis goodelliana Fern. Ottawa, Ont.; Nordegg, Alta.
Ancylis plagosana Clem. Aweme, Man.; Waterton Park, Nordegg, Alta.; Kaslo, Cranbrook, Saanich Dist., B.C.
Ancylis pacificana Wlshm. Kaslo, B.C.
Ancylis mediofasciana Clem. Digby, N.S.; Gaspé, Que.; Ottawa, Ont.; Aweme, Man.; Waterton Park, Alta.
Ancylis torontana Kft. Only known from the type from Toronto, Ont.
Ancylis tineana Hbn. Barrington Passage, N.S.; Aweme, Man.

Ancylis albacostana Kft. Ottawa, Ont.; Aweme, Man.
Hystricophora stygiana Dyar. Lethbridge, Calgary, Alta.; Mt. Arrowsmith (Fletcher), Vancouver, B.C.
Hystricophora asphodelana Kft. Calgary, Lethbridge, Waterton Park, Alta.; Keremeos, Vernon, B.C.
Hystricophora ochreicostana Wlshm. Aweme, Treesbank, Man.; Lethbridge, Alta.
Hystricophora taleana Grt. Aweme, Man.
Hystricophora vestaliana Zell. Aweme, Man.; Last Mt. Lake, Sask.

Species marked with an asterisk were described in the Can. Ent., 1925, LVII, pp. 12-23.

Coleoptera

(Arranged according to Leng's Catalogue of Coleoptera, 1920).

Cicindelidae
41 *Cicindela limbata* Say. Orion, Alta., (Seamans and Criddle). Approaching var. *nympha* Csy.
* *Cicindela osleri terracensis* Csy. Terrace, B.C., (Mrs. W. Hippisley).
* *Cicindela ostenta columbiana* Csy. B.C.
108 *Cicindela cuprescens* Lec. Aweme East, Man., (R. D. Bird).

Carabidae
Elaphrus divinctus Csy. Medicine Hat and Cypress Hills, Alta., (F. S. Carr).
Elaphrus bituberosus Csy. Terrace, B.C., (Hippisley).
237 *Blethisia multipunctata* L. Cypress Hills, Alta., (Carr).
* *Blethisia hudsonica* Csy. Edmonton, Alta., (Carr).
241 *Loricera caerulescens* L. Medicine Hat, Alta., (Carr).
* *Nebria curtulata* Csy. West St. Modest, Labrador, (Sherman).
* *Nebria hippisleyi* Csy. Terrace, B.C., (Mrs. Hippisley).
329 *Dyschirius aeneolus* Lec. Baldur, Man., (J. B. Wallis).
348a *Dyschirius montanus* Lec. Baldur, Man., (Wallis). Not typical.
* *Bembidion carrianum* Csy. Edmonton, Alta., (Carr).
* *Bembidion exiguiceps* Csy. Terrace, B.C., (Hippisley).
* *Bembidion oblectans* Csy. Edmonton, Alta., (Carr).
* *Bembidion fortunatum* Csy. Edmonton, Alta., (Carr).
* *Bembidion edmontonensis* Csy. Edmonton, Alta., (Carr).
* *Bembidion subexiguum* Csy. Terrace, B.C., (Hippisley).
* *Bembidion accuratum* Csy. Edmonton, Alta., (Carr).
* *Bembidion albertanum* Csy. Edmonton, Alta., (Carr).
* *Bembidion terracens* Csy. Terrace, B.C., (Hippisley).
* *Bembidion canadianum* Csy. Edmonton, Alta., (Carr).
728 *Bembidion henshawi* Hayd. Saskatoon, Sask., (N. J. Atkinson).
* *Patrobus canadensis* Csy. Edmonton, Alta., (Carr).
* *Hypherpes terracensis* Csy. Terrace, B.C., (Hippisley).
* *Hypherpes stoecus* Csy. Inverness, B.C.
* *Poecilus elucens* Csy. Edmonton, Alta., (Carr).
1155 *Poecilus occidentalis* Dej. Medicine Hat, Alta., (Carr).
* *Curtonotus subtilis* Csy. Stupart Bay, N.W.T.
* *Curtonotus albertinus* Csy. Edmonton, Alta., (Carr).
* *Curtonotus gilvipes* Csy. Manitoba.
* *Curtonotus brevipennis* Csy. West Hudson Bay.
* *Curtonotus manitobensis* Csy. Manitoba.
* *Curtonotus durus* Csy. Edmonton, Alta., (Carr).
* *Curtonotus biarcuatus* Csy. Edmonton, Alta., (Carr).
* *Celia vancouveri* Csy. B.C.
* *Celia marginatellus* Csy. Manitoba.
* *Celia parallela* Csy. Alberta, (Carr).
* *Celia albertas* Csy. Alberta, (Carr).
* *Celia funebris* Csy. Manitoba.
* *Celia winnipegensis* Csy. Winnipeg, Man.
* *Celia fragilis* Csy. B.C.
* *Celia frugalis* Csy. Manitoba.
* *Celia explanatula* Csy. B.C.
* *Celia cervicalis* Csy. Canada, ("probably Alta.").
* *Amara viridula* Csy. Alberta.
* *Amara obligua* Csy. B.C.
* *Amara inflaticollis* Csy. Manitoba.
* *Amara subarctica* Csy. Saskatchewan.
* *Amara carriana* Csy. Edmonton, Alta., (Carr).
* *Anchomenus albertanus* Csy. Edmonton, Alta., (Carr).
* *Agonum invalidum* Csy. Edmonton, Alta., (Carr).
* *Agonum terracens* Csy. Terrace, B.C., (Hippisley).
* *Europhilus* (*Platynus*) *carri* Csy. Edmonton, Alta., (Carr).

1537 *Platynus subcordatus* Lec. Medicine Hat, Alta., (Carr).
1646 *Lebia atriceps* Lec. Aweme, Man., (E. Criddle); Kelwood, Man., (J. May).
1649 *Lebia pulchilla* Dej. Winnipeg, Man., (Wallis). Not typical.
1650 *Lebia divisa* Lec. Saskatoon, Sask., (K. King).
1665 *Lebia montana* Horn. Medicine Hat, Alta., (Carr).
* *Cymindis kirbyi* Csy. Caribou, B.C.
* *Cymindis obliqua* Csy. Edmonton, Alta., (Carr).
* *Chlaenius albertanus* Csy. Edmonton, Alta., (Carr).
1806 *Chlaenius tomentosus* Say. Medicine Hat, Alta., (Carr).
1825 *Chlaenius nebraskensis* Lec. Medicine Hat and Cypress Hills, Alta., (Carr).
1879 *Piosoma setosa* Lec. Medicine Hat, Alta., (Carr).
* *Harpalus columbianus* Csy. Goldstream, B.C.
* *Harpalus instructus* Csy. Edmonton, Alta., (Carr).
* *Harpalus blanditus* Csy. Terrace, B.C., (Hippisley).
* *Harpalus nivalis* Csy. Saskatchewan.
* *Harpalus ferviculus* Csy. B.C.
* *Harpalus ventricosus* Csy. Spencer, B.C.
* *Harpalus durescans* Csy. Ft. Coulonge, Que.
* *Harpalus modulatus* Csy. Ft. Coulonge, Que.
* *Harpalus electus* Csy. Edmonton, Alta., (Carr).
* *Acupalpus canadensis* Csy. Mt. Royal, Que.

All the above new carabidae described in "Memoirs on the Coleoptera," Vol. XI, 1924.

Haliplidae

2305 *Haliplus cribarius* Lec. Medicine Hat, Alta., (Carr).

Dytiscidae

Coelambus compar Full. Aweme and Winnipeg, Man., (J. B. Wallis).
2405 *Coelambus farctus* Lec. Winnipeg, Man., (Wallis).
Coelambus hudsonicus Fall. Barnard Harbour, N.W.T.; erroneously recorded in report of Can. Arctic Exp. as *unguicularis* (Wallis).
2415 *Coelambus punctilineatus* Fall. Medicine Hat and Cypress Hills, Alta., (Carr).
2482 *Hydroporus 12-lineatus* Lec. Cawstone, B.C., (W. Metcalf).
2487 *Hydroporus occidentalis* Shp. Winnipeg, Man., (Wallis).
2495 *Hydroporus despectus* Shp. Aweme, Man., (Wallis).
Hydroporus pervicinus Fall. Onah and Aweme, Man., (Wallis); Transcona, Man., (G. S. Brooks).
Hydroporus labradorensis Fall. Stupart Bay, N.W.T.
2551 *Agabus punctulatus* Aube. Saskatoon, Sask., (N. J. Atkinson); Cypress Hills, Alta., (Carr).
2561 *Agabus nigripalpis* Sahlb. Panguirtuny Fiord, Baffin Land, (J. P. Saper).
2563 *Agabus confinis* Gyll. Thornhill, Man., (Wallis).
Agabus ontarionis Fall. Charleswood, Man., (Wallis); Aweme, Man., (R. M. White and Wallis).
Agabus ajax Fall. Tofield, Alta., (Carr).
2582 *Agabus tristis* Aube. Panguirtuny Fiord, Baffin Land, (J. P. Saper).
2612 *Scatopterus angustus* Lec. Aweme, Man., (White).
2613 *Scatopterus horni* Cr. Aweme, Man., (Wallis).
2627 *Colymbetes longulus* Lec. Kelwood, Man., (J. May).
2631 *Colymbetes strigatus* Lec. Medicine Hat, Alta., (Carr).

Gyrinidae

Gyrinus pleuralis Fall. Medicine Hat, Alta., (Carr).
2686 *Gyrinus aeneolus* Lec. Black Rapids and Ottawa, Ont., (R. Ozburn).

Hydrophilidae

* *Cymbiodyta vindicata* Fall. Terrace, B.C., (Hippisley).
Jour. N.Y. Ent. Soc., XXX, 1924.

Scydmaenidae

3169 *Scydmaenus badius* Csy. Aweme, Man., (White).

Colydiidae

3248 *Synchita fuliginosa* Melsh. Aweme, Man., (Criddle). Bred in oak.

Histeridae

* *Hister albertanus* Csy. Edmonton, Alta., (Carr).
6623 *Hister bimaculatus* L. Medicine Hat, Alta., (Carr).
* *Culistex deficiens* Csy. Alberta, (Carr).
6691 *Margarinotus guttifer* Horn. Medicine Hat, Alta., (Carr).
6893 *Saprinus estriatus* Lec. Waterton Lakes, Alta., (J. McDunnough).

Melyridae

7208 *Collops bipunctatus* Say. Lethbridge, Alta., (W. Carter).
7437 *Listrus senilis* Lec. Medicine Hat, Alta., (Carr).

Cleriidae
7545 *Cymatodera inornata* Say. Treesbank, Man., (White).

Meloidae
8017 *Epicauta maculata* Say. Dallard, Sask., (King).

Elateridae
8228a *Cryptohypnus lucidulus* Mann. Calgary, Alta., (Tams).
8971 *Ectamenogonus melsheimeri* Leng. Victoria Beach, Man., (Wallis).

Melasidae
9142 *Dromaeolus harringtoni* Horn. Victoria Beach, Man., (L. Roberts).

Buprestidae
9372a *Buprestis nuttalli consularis* Gory. Wawanesa, Man., (White).
9436 *Chrysobothris blanchardi* Horn. Victoria Beach, Man., (Brooks, Roberts, Wallis).
9448 *Chrysobothris pusilla* Cast. Victoria Beach, Man., (Brooks and Wallis).
Agrilus frosti Knull. Stonewall, Man., on oak, (Wallis).
9498 *Agrilus acutipennis* Mann. Douglas Lake, Man., (E. Criddle).
9523a *Agrilus arcuatus torquatus* Lec. Victoria Beach, Man., (Roberts).
9548 *Agrilus vittaticollis* Rand. Treesbank, Man., (White).

Ostomidae
* *Ostoma columbiana* Csy. Terrace, B.C., (Hippisley).

Nitidulidae
10042 *Corpophilus hemipterus* L. Winnipeg, Man., (Roberts).

Erotylidae
* *Triplax carri* Csy. Edmonton, Alta., (Carr).

Cryptophagidae
* *Cryptophagus keeni* Csy. Matlakatla, B.C., (J. H. Keen).
* *Macrodea antennalis* Csy. Edmonton, Alta., (Carr).

Mycetophagidae
* *Lendomus politus* Csy. St. Lawrence Valley, Que.

Coccinelidae
10905 *Hyperaspis disoluta* Cr. Aweme East, Man., (White).
10954 *Hyperaspidus vittigera* Lec. Medicine Hat and Cypress Hills, Alta., (Carr); Bow Slope, Alta., (Carter).
11165 *Hippodamia sinuata* Muls. Penticton, B.C., (B. Farmer); Calgray, Alta., (Bird).
* *Hippodamia uteana quadraria* Csy. Edmonton, Alta., (Carr).
* *Hippodamia sinuata albertana* Csy. Edmonton, Alta., (Carr).
11194a *Adalia humeralis* Say. Medicine Hat, Alta., (Carr).
* *Anisocalvia vancouveri* Csy. B.C.
11204 *Anatis lecontei* Csy. Medicine Hat, Alta., (Carr).

Tenebrionidae
12008 *Embaphion muricatum* Say. Medicine Hat, Alta., (Carr).
12297 *Eleates depressus* Rand. Victoria Beach, Man., (Wallis); Aweme, Man., (Criddle and Bird).
* *Coelocnemis columbiana* Csy. B. C. (Kemp).
* *Iphthinus salebrosus* Csy. Matlakatla, B.C., (Keen).

Melandryidae
12568 *Serropalpus barbatus* Schl. Onah, Man., (White).

Plinidae
12621 *Ptinus californicus* Lec. Peachland, B.C., (Metcalf).

Anobiidae
12689 *Sitodrepa panicea* L. Transcona, Man., (Mrs. G. S. Brooks).

Bostrichidae
12902 *Bostrichus bicornis* Web. Aweme, Man., (Criddle).

Scarabaeidae
13112 *Aphodius denticulatus* Hald. Medicine Hat, Alta., (Carr).
13620 *Polyphylla decemlineata* Say. Cabra, Sask., (King).
13652 *Dichelonyx diluta* Fall. Annapolis Royal N.S., (R. P. Gorham).
13671 *Dichelonyx decolorata* Fall. Vernon, B.C., (E. P. Venables).
13694 *Hoplia trifasciata* Say. Victoria Beach, Man., (Brocks and Wallis).
13978 *Cremastochilus incisus* Csy. Medicine Hat, Alta., (Carr).

Cerambycidae

* *Strangalia apicata* Csy. B.C.
14615 *Anacomis litigiosa* Csy. Saskatoon, Sask., (N. J. Atkinson).
* *Anacomis terracensis* Csy. Terrace, B.C., (Hippisley).
* *Anacomis basalis* Csy. Terrace, B.C., (Hippisley).
14694 *Xylotrechus nauticus* Mann. Waterton Lakes, Alta., (McDunnough).
14961 *Astylopsis guttata* Say. Victoria Beach, Man., (Wallis and Roberts).
15056 *Pogonocherus mixtus* Hald. Victoria Beach, Man., (Wallis); Aweme, Man., (Wallis and Criddle).
15111 *Saperda horni* Joutl. Winnipeg, Man., (A. V. Mitchener).
15148 *Oberea bimaculata* Oliv. Aweme, Man., (Wallis and White).
15168 *Tetraopes canescens* Lec. Pelican Lake, Man., (Chaplin); Baldur, Man., (White).
15182 *Tetraopes femoratus* Lec. Pelican Lake, Man., (Chaplin).
15183 *Tetraopes collaris* Horn. Winnipeg, Man., (Wallis).

Chrysomelidae

15211 *Donacia distincta* Lec. Aweme, Man., (E. Criddle).
15220 *Syneta carinata* Mann. Victoria Beach, Man., (G. S. Brooks); Waterton Lakes, Alta., (Seamans).

All new species by Casey are from "Memoirs on the Coleoptera," Vol. XI, 1924.

15267 *Coscinoptera dominicana* Fab. Baldur, Man., (White).
15287 *Saxinis saucia* Lec. Aspen Grove, B.C., (Paul Vroom).
15299 *Chlamys cribripennis* Lec. Winnipeg, Man., (Wallis).
15534d *Bassareus sellatus* Suffr. Waugh, Man., and Victoria Beach, Man., (Wallis).
15549 *Nodonota puncticollis* Say. Medicine Hat, Alta., (Carr).
15566 *Graphops varians* Lec. Medicine Hat, Alta., (Carr).
15617 *Glyptoscelis albida* Lec. Medicine Hat, Alta., (Carr).
* *Phytodecta americana* Schaef. Man. to Alta.; previously identified as *pallida*. Jour. N.Y. Ent. Soc., XXXII, 1924.
15703 *Gastrodea cyanea* Melsh. Cypress Hills, Alta., (Carr).
* *Galerucella kalmiae* Fall. N.B., (Gorham); Halifax, N.S., (Harrington); Megantic, Que., (Curran); Ottawa, Ont., (Harrington); Mer Bleue, Ont., (Ozburn and Richardson); Sudbury, Ont., (Evans). Feeds on kalmia.
* *Galerucella spiraeae* Fall. St. Thomas, Ont., (H. G. Dustan).
The above two species described in Bull. 319, Maine Agr. Sta., 1924.
15821 *Luperodes torquatus* Lec. Victoria, B.C., (Buckell).
15861 *Hypolampsis pilosa* Ill. Medicine Hat, Alta., (Carr).
15868a *Oedionychis scripticollis* Say. Medicine Hat, Alta., (Carr).
* *Disonycha asteris* Schaef. Winnipeg, Man., (Willis); Aweme, Man., (Criddle); Estevan, Sask., (Criddle); Moose Jaw, Sask., (Macoun); Lethbridge, Alta., (Seamans); Edmonton, Alta., (Carr).
* *Disonycha davisi* Schaef. New Brunswick, Vineland, Ont., (Curran); Onah, Man., (Wallis).
Jour. N.Y. Ent. Soc., XXXII, 1924.
15922 *Haltica corni* Woods. Hillier and Sudbury, Ont., (Evans).
* *Chaetocnema protensa splendida* Gent. Aweme, Man., (Criddle); Rosthern, Sask., (King); Edmonton, Alta., (Carr).
Ent. News, Vol. XXXV, No. 5, 1924.
* *Longitarsus pallescens* Blat. Prince Edward Co., Ont., (Evans).
Jour. N.Y. Ent. Soc., Vol. XXXII, 1924.
16120 *Brachycoryna montana* Horn. Medicine Hat, Alta., (Carr).

Curculionidae

16364 *Rhynchites macrophthalmus* Schf. Stonewall, Man., (Wallis).
16620 *Evotus naso* Lec. St. Mary's River, Alta., (Bird).
16765 *Phytonomus nigrirostris* Fab. Victoria, B.C., (W. Downes).
16863 *Pissodes rotundatus* Lec. Grand Marais, Man., (Wallis); Onah, Man., (White).
17010 *Promecotarsus fumatus* Csy. Aweme, Man., (White).
17299 *Pseudoanthonomus crataegi* Walsh. Stonewall, Man., (Wallis); Aweme, Man., (Criddle).
17341 *Orchestes illinoisensis* Fall. Stonewall, Man., (Wallis).
17360 *Miarus hispidulus* Payk. Aweme, Man., (White).
17735 *Acanthoscelis curtus* Say. Medicine Hat, Alta., (Carr).
17760 *Coeliodes flavicaudis* Boh. Medicine Hat, Alta., (Carr).
17835 *Mecopeltus fuliginosus* Dietz. Aweme, Man., (White); Peachland, B.C., (Wallis).
18002 *Thecesternus humeralis* Say. Milk River, Alta., (Bird).
18090 *Sphenophorus mormon* Chitt. Stonewall, Man., (Wallis); Victoria Beach, Man., (Brooks).
* *Sphenophorus serratipes* Chitt. Medicine Hat, Alta., (Carr).
Proc. Ent. Soc. Wash., XXVI, No. 6, 1924.

Diptera

Prepared by C. H. Curran.

(The numbers at the left refer to the page in Aldrich's catalogue on which the name of the genus appears.)

Tipulidae
* * *Rhabdomastix (Sacandaga) borealis* Alexander. Hurricane, Alaska.
* 89* *Limnophila (Neolimnophila) ultima alaskana* Alexander. Healy, Alaska.
* 84* *Erioptera aldrichi* Alexander. Valdez, Alaska.
* * *Erioptera alaskensis* Alexander. Alaska.
* * *Ormosia curvata* Alexander. Skagway, Alaska.
* * *Ormosia decussata* Alexander. Ketchikan, Alaska.
* * *Ormosia proxima* Alexander. Skagway, Alaska.

The above described in Proc. U.S.N.M., LXIV, Article 10.
* 88* *Trichocera bituberculata* Alexander. Alaska.

Ins. Insc. Men, XII, 81.

Mycetophilidae
* 142* *Boletina anticus* Garrett. Michel, B.C.
* * *Boletina antomus* Garrett. Michel, B.C.
* * *Boletina astacus* Garrett. Caulfields, B.C.
* * *Boletina differens* Garrett. Fernie, B.C.
* * *Boletina jocunda* Garrett. B.C.
* * *Boletina montanus* Garrett. Fernie, B.C.
* * *Boletina shermani* Garrett. B.C.
* * *Mycomya ampla* Garrett. Banff, Alta.
* * *Mycomya armata* Garrett. Caulfields, B.C.
* * *Mycomya atus* Garrett. B.C.
* * *Mycomya autumnalis* Garrett. Michel, B.C.
* * *Mycomya caufieldi* Garrett. Caulfields, B.C.
* * *Mycomya cranbrooki* Garrett. Cranbrook, B.C.
* * *Mycomya difficilis* Garrett. Cranbrook, B.C.
* * *Mycomya durus* Garrett. Vancouver, B.C.
* * *Mycomya echinata* Garrett. Michel, B.C.
* * *Mycomya humidus* Garrett. Michel, B.C.
* * *Mycomya magna* Garrett. Fernie, B.C.
* * *Mycomya oviducta* Garrett. Michel, B.C.
* * *Mycomya polleni* Garrett. Cranbrook, B.C.
* * *Mycomya shermani* Garrett. Michel, B.C.
* * *Mycomya terminata* Garrett. B.C.
* * *Mycomya vulgaris* Garrett. Fernie, B.C.

The above described in Ins. Insc. Men., XII, 63.

Stratiomyidae
* 184 *Odontomyia pilimana* Loew. Douglas, Man., July 29, (R. D. Bird; E. Criddle).
* *Odontomyia vertebrata* Say. Douglas Lake, Man., July 30, (E. Criddle); Stockton, Man., July 29, (N. Criddle).

Tabanidae
* 195 *Chrysops aestuans* V. d. Wulp. Penticton, Oliver and Vernon, B.C., (Buckell, Vroom, Gillespie); Dunedin, Sask.
* *Chrysops hilaris* O. S. Truro, N.S., July 21, (Whitehead).

Asilidae
* 255 *Ospriocerus ventralis* Coq. Oliver, B.C., July 17, (Buckell).
* *Eucertopogon albibarbis* Curran. Medicine Hat, Alta., April, (F. S. Carr).
* 261 *Holopogon seniculus* Loew. Bestville, Sask., July 5, (King).
* *Holopogon tibialis* Curran. Covey Hill, Que., July 17, (G. S. Walley).
* 282 *Asilus nitidifacies* Hine. Hopedale, Labrador, Aug. 19, 1923, (Perritt); Seven Islands, Que., July 9, (F. W. Waugh).

Empididae
* 311* *Platypalpus hians* var. *fuscohalteratus* Melander. Sudbury, Ont.
* * *Platypalpus holosericus* Melander. Megantic Que.; St. John, N.B.
* * *Platypalpus pectinator* Melander. Banff, Alta., (Garrett).

The above described in Occ. Pap. Boston Soc. N.H., V. 85.

Dolichopodidae
* 293* *Nothosympycnus cilifemoratus* Van Duzee. Alaska.
* 290* *Campsicnemus calacaratus* Van Duzee. Alaska.
* * *Hydrophorus minimus* Van Duzee. Alaska.

The above described in Proc. U.S.N.M., LXIII, Art. 21.
* *Hydrophorus algens* Wheeler. Aweme, Man., Oct. 7, 1924, (N. Criddle).
* * *Paraphrosylus nigripennis* Van Duzee. Alaska.

Pan Pac. Ent., 1.
291* *Argyra ciliata* Van Duzee. Alaska.
Proc. U.S.N.M., LXIII, Art. 21.
292* *Rhaphium subarmatum* Curran. Oromocto, N.B.
Psyche, XXXI, 228.
288* *Diaphorus brevinervis* Van Duzee. Alaska.
291* *Porphyrops albibarba* Van Duzee. Alaska.
* *Porphyrops borealis* Van Duzee. Alaska.
* *Porphyrops terminalis* Van Duzee. Alaska.
The above described in Proc. U.S.N.M., LXIII, Art 21.
295 *Medeterus halteralis* Van Duzee. Aylmer, Que., July 31, 1924, (Curran). Ont
Medeterus vittatus Van Duzee. Aylmer, Que., July 31, (Curran).
298 *Dolichopus barbicauda* Van Duzee. Stockton, Man., July 29, (Criddle).
Dolichopus detersus Loew. Stockton, Man., July 29, (Criddle).
Dolichopus longimanus Loew. Slave Lake, Alta., July, Aug., (Owen Bryant).
Dolichopus luteipennis Loew. Aylmer, Que., Aug. 8, (Curran).
Dolichopus nubifer Van Duzee. Stockton, Man., July 29, (Criddle).
Dolichopus quadrilamellatus Loew. Strathroy, Ont., July, (H. F. Hudson).
Dolichopus remipes Wahl. Stockton, Man., July 29, (J. B. Wallis).
305* *Gymnopternus nigricoxa* Van Duzee. Joliette, Que.
Occ. Pap. Bos. Soc. Nat. Hist., V. 103.
Gymnopternus subulatus Loew. Aylmer, Que., Aug. 1, 2, (Curran).
Gymnopternus fimbriatus Loew. Hemmingford, Que., June 29, 1923, (Curran).
306 *Hercostomus ornatipes* V.D. Ottawa, July, August, (Curran); Hull, Que., July 5, 1923, (Curran); very local.
Hercostomus unicolor Loew. Aylmer, Que., Aug. 2, (Curran).

Syrphidae
406* *Cerioides proxima* Curran. Guelph, Ont.
Psyche, XXXI, 228.
344* *Microdon manitobensis* Curran. Megantic, Que.
Psyche, XXXI, 227.
* *Microdon pseudoglobosus* Curran. Aweme, Man.
Psyche, XXXI, 226.
376 *Volucella satur* O. S. Medicine Hat, Alta., Aug. 20, (F. S. Carr).
Volucella avida O. S. Victoria, B.C., (A. W. Hanham).
Epistrophe genualis Williston. Kentville, N.S., May, (Gorham).
Cnemodon auripleura Curran. Calgary, Alta., June, 1923, (G. Salb); Lethbridge, Alta., July 28, 1923, (Strickland).
Cnemodon rita Curran. Waterton, Alta., July 14, 1923, (Strickland).
349* *Pipiza nigrotibiata* Curran. Bathurst, N.B.
Occ. Pap. Bos. Soc. Nat. Hist., V. 81.
Cynorhina nigra Williston. Kentville, N.S., (R. P. Gorham).
394 *Asemosyrphus willingi* Smith. Elk Island Alta., August 4 to 12, 1923; Tofield, Alta., May 22, 1923, (E. H. Strickland).

Platypezidae
341 *Platypeza flavicornis* Loew. Kings Co., Nova Scotia, Sept. 14, 1920, (reared from wormy mushroom).

Tachinidae
438 *Pseudapinops nigra* Coq. Macdiarmid, Ont., (L. Nipigon), July 11, 1923, (Bigelow).
Mericia bicarina Tothill. Hedley, B.C., Aug., (Garrett).
Mericia nigropalpis Tothill. Macdiarmid, Ont., June, (Bigelow).
* *Ernestia fasciata* Curran. Cranbrook, B.C.
Ent. News, XXXV, No. 7,246.
* *Mericia campestris* Curran. Aweme, Man.
Ent. News, XXXV, 249.
* *Mericia fasciventris* Curran. Aylmer, Que.
Ent. News, XXXV, 248.
* *Mericia triangularis* Curran. Aweme, Man.
Ent. News, XXXV, 247.
460* *Phorocera setifrons* Ald and Webber. Sask.
Proc. U.S.N.M., LXIII, Art. 17, 71.
* *Phorocera silvatica* Ald. and Webber. B.C.
Proc. U.S.N.M., LXIII, Art. 17, 72.
* *Phorocera tenuiseta* Ald. and Webber. B.C.
Proc. U.S.N.M., LXIII, Art. 17, 82.

Sarcophagidae
476 *Hilarella decens* Townsend. Osoyoos, B.C., May 16, (Buckell).
510 *Sarcophaga atlanis* Aldrich. Joliette, Que., July 6, (J. Ouellet).
Sarcophaga coloradensis Aldrich. Aylmer, Que., May 21, June 24, (Curran).

Sarcophaga falciformis Aldrich. Saskatoon, Sask., June 6, 29, 1923, (K. M. King).
Sarcophaga larga Aldrich. Hemmingford, Que., Aug. 19 and 22, (T. Armstrong).
Sarcophaga libera Aldrich. Macdiarmid, Ont., June 29, 1922, (N. K. Bigelow).
Sarcophaga planifrons Aldrich. Plato, Sask., Aug. 2, 1923, (King).
Sarcophaga uliginosa Kramer. Macdiarmid, Ont., July 12, 1922, (N. K. Bigelow).

Calliphoridae
* *Francilia alaskensis* Shannon. Alaska.
Ins. Insc. Men., XII, 74.
523* *Protocalliphora splendida*, var. *aenea* Shannon and Dobroscky. Ont.
Journ. Wash. Acad. Sci., XIV, 251.
* *Protocalliphora splendida* var. *hesperia* Shannon and Dobroscky. B.C.
Journ. Wash. Acad. Sci., XIV, 251.

Muscidae
553 *Eustalomyia vittipes* Zett. Montreal, Que.; Aylmer, Que., June, (Curran).
Eustalomyia festiva Zett. Hemmingford, Que., July, (T. Armstrong); Aylmer, Que., July, (Curran).
551* *Hydrophoria packardi* Malloch. Labrador.
Ann and Mag. Nat. Hist., XIV, 514.
Xenophorbia muscaria Mg. Oliver, B.C., April, (C. Garrett); Vancouver, Island, B.C., (Hanham).
551 *Hylemyia curvipes* Malloch. Hull, Que., May, (Curran).
Hylemyia fuscohalterata Malloch. Teulon, Man., May, (A. J. Hunter).
Hylemyia hinei Malloch. Hardisty Island, Great Slave Lake Region, June, (J. Russell).
Hylemyia pluvialis Malloch. Kentville, N.S., July, (Gorham).
Hylemyia marginata Stein. Hedley, B.C., July, (Garrett); Revelstoke Mt., B.C., Aug., (Vroom); Mt. Cheam, B.C., Aug., (Fletcher).
Hylemyia setiventris Stein. Hedley, B.C., July, Aug., (Garrett).
Hylemyia spiniventris Coq. Hedley, B.C., July, Aug., (Garrett).
558 *Pegomyia fuscofasciata* Malloch. Aylmer, Que., Aug., (Curran).
Pegomyia lipsea Walk. Teulon, Man., August, (A. J. Hunter).
554 *Eremomyia humeralis* Stein. Aylmer, Que., May, (C. B. Hutchings).
Eremomyodes cylindrica Stein. Hull, Que., May, (Curran).
Eremomyodes fusciceps Malloch. Aylmer, Que., June, (Curran).
* *Fannia canadensis* Malloch. Gold Rock, Ontario, July 21, 1908, (H. H. Newcomb).
Ann. Mag. Nat. Hist., XIII, 423.
Fannia glaucescens Zett. Teulon, Man., May, (A. J. Hunter); Kentville, N.S., July, (R. P. Gorham).
Fannia incisurata Zett. Teulon, Man., July, (A. J. Hunter).
Fannia leucosticta Mg. Saanich Dist., B.C., Sept., (W. Downes).
Fannia manicata Mg. Aylmer, Que., Oct., (Curran).
Fannia tibialis Malloch. Teulon, Man., Aug., (Hunter).
539 *Coelomyia spathulata* Zett. Hedley, B.C., July, (C. Garrett).
534 *Hydrotaea dentipes* Fabr. Seven Islands, Quebec, June, (F. W. Waugh).

Scatophagidae
568 *Scatophaga rubicunda* Malloch. Panguirtung Fiord, Baffinland, July 24, (J. D. Soper).

Helomyzidae
573* *Leria serrataria* Garrett. Mount Apex, B.C.
Ins. Insc. Mens., XII, 26.
* *Amoebaleria perplexus* Garrett. Wilson Creek, Michel, B.C.
Ins. Insc. Mens., XII, 27.
* *Lutomyia distincta* Garrett. Bentley's Siding, Rushmere, Windermere, B.C.
Ins. Insc. Mens., XII, 30.

Borboridae
* *Leptocera (Collinella) fumipennis* Spuler. Nelson, B.C.
Annals Ent. Soc. Am., XVII, 110.
* *Leptocera (Ptermis) parvipennis* Spuler. Alaska.
Psyche, XXXI, 132.
* *Leptocera (Opacifrons) pellucida* Spuler. Wash.
Psyche, XXXI, 127.

Ortalidae
594* *Psairoptera similis* Cresson. Star City, Sask.
Trans. Am. Ent. Soc., L. 236.

Piophilidae
620* *Piophila privigna* Melander. Mass.
Psyche, XXXI, 86.

Hymenoptera

(Prepared by H. L. Viereck)

Tenthredinidae

Kaliofenusa ulmi Sundewal. Injurious to elms in southern Quebec.
Pristophora californicus Marl. Metchosin, B.C., May 18, 1924, (W. Downs).
Tenthredella nigricollis Kby. Hemmingford, Que., July 28, 1924, (T. Armstrong).

Cephidae

Janus integer Nort. Edmonton, Alta., July 1, 1923, (E. H. Strickland).

Vipionidae

Ichneutidea secunda Roh. Jordon, Ont., Aug. 18, 1922, ex *Metallus bethunei* MacG., Aug. 31, 1922, ex. *Sterictiphora*(?) *zabriskei* Ashm. (W. A. Ross).
Dolichogenidea crassicornis Prov. Bilby, Alta., Aug. 10, 1924, (O. Bryant).
Microgaster alaskensis Ashm. Slave Lake, Alta., Aug. 15, 1924, (O. Bryant).
Microbracon montowesei Vier. Jordan, Ont., Sept. 20, 1917, (W. A. Ross).
Habrobracon johannseni Vier. Jordan, Ont., Sept. 8, 1917, (W. A. Ross).

Braconidae

Meteorus fumipennis Mues. Midday Val., Merritt, B.C., June 23 to July 25, 1923, (R. Hopping).
Ascogaster carpocapsae Vier. Vineland, Ont., April 7, 1924, ex *Carpocapsa pomonella* (W. A. Ross).
Bracon montrealensis Morr. Jordan, Ont., Sept. 16, 1914, (W. A. Ross).
Aleiodes stigmator Say. Beamsville, Ont., Aug. 27, 1918; Jordan, Ont., June 13, 1917, (W. A. Ross); Aweme, Sept. 4, 1923, (N. Criddle); October 7, 1923, (R. M. White).

Ichneumonidae

Campoplex phthorimaeae Cush. Oliver, B.C., May 19, 1923, (C. B. D. Garrett).
Campoplex augustus Vier. Aylmer, Que., June 10, July 9, 1924, (C. H. Curran); August 14, 1924, (A. R. Graham).
Campoplex annulipes Cress. Hull, Que., May 14, 1924, (C. H. Curran); Aylmer, Que., August 1, 14, 1924, (A. R. Graham); Waterton, Alta., July 10, 1923, (H. L. Seamans); Sudbury, Ont., 1892, (Evans).
Campoplex eureka Ashm. Victoria, B.C., August, 1923, (K. F. Auden).
Cymodusa distincta Cress. Cottage Beaulieu, Que., August 16, 1901, (*Beaulieu*).
Neonortonia genuina Nort. Vancouver Island, B.C., (G. W. Taylor); Banff, Alta., June 16, 1922, (C. B. D. Garrett).
Pseuderipternoides porrectus Cress. Hull, Que., Sept. 14, 1897, (W. H. Harrington).
Sagaritis websteri Vier. Oliver, B.C., May 24, 1923, (C. B. D. Garrett).
Sagaritis oxylus Cress. Picton, Ont., May 25, (W. H. Harrington).
Sagaritis taeniatus Vier. Ottawa, Ont., July 19, 20, 1918, birch, (C. B. Hutchings).
Sagaritis flavicincta Ashm. Grimsby, Ont., May 11, 1894, (Metcalf).
Sagaritis conjunctus Cress. Ottawa, Ont., (W. H. Harrington).
Sagaritis conjunctiformis Vier. Ottawa, Ont., Sept. 3, 1908, (C.E.F.).
Sagaritis californicus Holmg. var. Agassiz, B.C., July 17, 1921, (H. Glendenning); Oliver, B.C., May 14, 1923, (C. B. Garrett); Royal Oak, June 30, 1917, (W. Downs).
Sagaritis aprilis Vier. Macdiarmid, Lake Nipigon, Ont., July 7, 1923, (N. K. Bigelow).
Campoplegidea villosa Nort. Brule River, Riordan Limits, Que., July 31, 1918; Aylmer, Que., August 9, 1924, (A. R. Graham).
Campoplegidea diversa Nort. Trenton, Ont., July 21, 1907, (Evans).
Campoplegidea wyomingensis Vier. Saskatoon, Sask., June 22, 1923, (N. J. Atkinson).
Campoplegidea laticincta Cress. Sudbury, July 6, 1889, (Evans); Radison, Sask., July 30, 1907, (J. Fletcher); Aylmer, Que., July 1, 1924, (C. B. Hutchings); Montreal, Que., July 7.
Neopristomerus appalachianus var. *dorsocastaneus* Vier. Lethbridge, Alta., May, June, September, 1923.
Peniscus pallens Cush. Treesbank, Man., July 22, 1910, (J. B. Wallis).
Paniscus ocellatus Vier. Alta.
Paniscus alaskensis Ashm. Kaslo, B.C.
* *Protarchoides mandibularis* Cush. Wellington, B.C.
1924, Proc. U.S.N.M., LXIV, 9.
* *Cidaphus occidentalis* Cush. Revelstoke, B.C.
1924, Proc. U.S.N.M., LXIV, 5.
Opheltes glaucopterus L. Aweme, Man., August 25, 1924, (R. D. Bird).
Ctenochira leucozonata Ashm. Orillia, Ont., August 2, 1924, (H. L. Viereck).
Glypta evetriae Cush. Agassiz, B.C., May, (R. Glendenning.)
Hymenoepimecis wilti Cress. ♂, Aweme, Man., June 28, 1921, (N. Criddle).
Thysiotorus smithi Cush. Ottawa, Ont., June 27, K.I.; August 18, 1894; Hull, Que., August 16, 1894, (W. H. Harrington); Queen's Park, Aylmer, Que., August 18, 1924, (A. R. Graham).
Trichocryptus hirtifrons Ashm. Ottawa, Ont., April 29, 1983, (W. H. Harrington).

Encyrtidae

Anabrolepis zetterstedti Westw. Vernon, B.C., ex *Lepidosaphes ulmi*.

Belytidae

* *Anectata canadensis* Fouts. Gull Lake, Ont., June 13, 1921, (H. S. Parish).

Sphecidae

Didineis peculiaris Fox. Victoria, Vernon, B.C., June 16, July 6, 1923, K. F. Auden; June 19, 1924, (E. A. Rendel).

Halictidae

Halictus confusus Rob. Jordan, July 28, August 14, 1914, June 27, 29, July 28, 1917,, (W. A. Ross); May 23, September 8, 1915, (C. H. Curran); Vineland, July 25, 1917 (W. A. Ross).

Andrenidae

Andrena compactiscopa Vier. Agassiz, B.C., June 4, 1923, (R. Glendenning). First Canadian record.

Andrena decussata Vier. Waterton, Alta., July 13, 1923, (E. H. Strickland).

Andrena marioides Vier. Calgary, April 23, 1915, (F. H. Wolley-Dod), (F. W. L. Sladen); June 12, 1923, (R. D. Bird).

Andrena neurona Vier. Duncan, B.C., April 12, 1921, (W. B. Anderson); Penticton, May 10, 1919, (E. R. Buckell).

Andrena parnassiae Ckll. Edmonton, Alta., August 19, 1923, (E. H. Strickland).

Nomadidae

Nomada cuneata var. *quadrisignata* Rob. Kentville, N.S., June 22, 1914, (C.A.G.).

Euceridae

Tetralonia dilecta Cress. St. Mary River, Alta., July 20, 1923, (R. D. Bird).

Colletidae

Colletes willistoni Rob. Kentville, N.S., June 18, 1914, (C.A.G.).

Megachilidae

* *Osmia proposita* Sandhouse. Nanaimo Biological Sta., B.C., June 24, 1920; 1924, Proc. Calif. Acad. Sci., XIII, 355.

* *Osmia seclusa* Sandhouse. Vancouver, B.C., June 16, 1896, (Livingston). 1924, Proc. Calif. Acad. Sci., XIII, 352.

* *Osmia sedula* Sandhouse. Nanaimo Biological Station, B.C., June 24, 1920.

HEMIPTERA

Myridae

* *Plagiognathus politus pallidicornis* Kt. Parry Sound, Ont., (H. S. Parish).
* *Plagiognathus nigronitens* Kt. Parry Sound, Ont., (Parish).
* *Plagiognathus flavicornis* Kt. Ottawa, Ont., (G. Beaulieu).
* *Plagiognathus alboradialis* Kt. Parry Sound, Ont., (Parish).
* *Plagiognathus flavoscutellatus* Kt. Truro, N.S., (W. H. Brittain); Hull, Que., (J. Beaulne).
* *Plagiognathus brevirostris* Kt. Spruce Brook, Newfoundland, (G. P. Englehardt).
* *Plagiognathus albatus vitticutis* Kt. Montreal, Que., (G. A. Moore).
* *Plagiognathus laricicola* Kt. Nordegg, Alta., (J. McDunnough).
* *Plagiognathus repetitus* Kt. Nova Scotia, (Brittain).
* *Microphylellus tumidifrons* Kt. Truro, N.S., (Brittain).
* *Microphylellus nigricornis* Kt. Parry Sound, Ont., (Parish).
* *Psallus drakei* Kt. Nordegg, Alta., (McDunnough).
* *Psallus alnicenatus* Kt. Truro, N.S., (Brittain).
* *Orthotylus basicornis* Kt. Hull, Que., and Roberval, Que., (Beaulieu).
* *Orthotylus neglectus* Kt. Truro, N.S., (R. Matheson).
* *Orthotylus immaculatus* Kt. Ottawa, Ont., (Beaulieu).
* *Pilophorus uhleri* Kt. Ottawa, Ont., (Beaulieu).
* *Neoborus glaber* Kt. Ottawa, Ont., (McDunnough).
* *Polymerus punctipes* Kt. Montreal, Que., (Moore).
* *Polymerus opacus* Kt. Parry Sound, Ont., (Parish).
* *Phytocoris junceous* Kt. Nordegg, Alta., (McDunnough).
* *Platytylellus fraternus* Kt. Aylmer, Que., (C. B. Hutchings and A. R. Grayham).
* *Platytytellus nigroscutellatus* Kt. Jordan, Ont., (W. A. Ross).

The above described in "The Hemiptera of Connecticut," Bull. 34, 1923.

HOMOPTERA

* *Cyrtolobus funkhouseri* Woodruf. "Canada."
* *Cyrtolobus puritanus* Woodrf. "White Lake."

Jour. N.Y. Ent. Soc., XXXII, 1924.

NEUROPTERA

Mantispidae

Mantispa pulchella Banks. Vernon, B.C., (Rendell).

Limnephilidae

* *Limnephilus forcipatus* Banks. Lobstock Island, Ft. Chippewyan, (F. Harper).
* *Ecclisomyia complicata* Banks. Go Home Bay, Ont., (E. M. Walker).
* *Chilostigma subborealis* Banks. Wellington, B.C.; Lake Minnawanka, Alta.
* *Anolopsyche pallida* Banks. Winnipeg Lake, Man., (Robt. Kennicott).
* *Apatania canadensis* Banks. Winnipeg, Man., (J. B. Wallis).

Leptoceridae

* *Mystaerides canadensis* Banks. Lucalle, Que., Sherbrooke, Que., (P. A. Begin).
The above species described in Bull. Mus. Comp. Zool., LXV, 1924.

EPHEMEROPTERA

The following list of Canadian species of this order has been prepared by J. McDunnough and is as complete as our present knowledge permits. The material on which it is based is contained in the Canadian National Collection.

Ephemeridae

Polymitarcys albus Say. Aweme, Treesbank, Man.
* *Hexagenia atrocaudata* McD. Ottawa, Ont.
* *Hexagenia rigida* McD. Lanoraie, Laprairie, Que.; Ottawa, Kingston, Orillia, Pt. Stanley, Ont.; Winnipeg, Man.
Hexagenia limbata Guer. Lanoraie, Montreal, Que.; Ottawa, Kingston, Algonquin Park, Orillia, Ont.; Winnipeg, Treesbank, Man.; Penticton, B.C.
Ephemera simulans Wlk. Lanoraie, Laprairie, Que.; Ottawa, Kingston, Lake of Bays, Ont.; Aweme, Man.; Waterton Park, Alta.; Oliver, Penticton, B.C.
Ephemera varia Eaton. Covey Hill, Que.
Ephemera guttulata Pict. Covey Hill, Montreal, Deschenes, Que.
Pentagenia vittigera Walsh (*quadripunctata* Walsh). Aweme, Man.
Potamanthus diaphanus Needh. The type specimens were taken on the Niagara River. The species is not represented in the collection.

Baetidae

* *Leptophlebia moerens* McD. Covey Hill, Hull, Que.
* *Leptophlebia volitans* McD. Lachine, Hull, Que.; Ottawa, Algonquin Park, Seabright, Ont.
* *Leptophlebia guttata* McD. Covey Hill, Kirk's Ferry, Que.
Leptophlebia mollis Eaton. Covey Hill, Hull, Que.
Leptophlebia debilis Walk. (*separata* Ulm.). Kirk's Ferry, Hull, Que.; Aweme, Man.
* *Leptophlebia heteronea* McD. Waterton Park, Banff, Nordegg, Alta.; Nicola, B.C.
Leptophlebia pallipes Hagen. Oliver, B.C.
Leptophlebia johnsoni McD. Covey Hill, Que.
Leptophlebia praepedita Eaton. Covey Hill, Hull, Que.; Ottawa, Coldstream, Ont.; Gimli, Man.
Blasturus nebulosus Wlk. Fredericton, N.B.; Megantic, Hull, Que.; Nordegg, Waterton Park, Alta.; Aspen Grove, B.C.
Blasturus cupidus Say. Annapolis, N.S.; Hull, Que.; Ottawa, Ont.; Aweme, Man.; Waterton Park, Alta.
Blasturus gravastellus Eaton. Osoyoos, B.C.
Choroterpes basalis Banks. Hull, Aylmer, Que.; Ottawa, Ont.
* *Choroterpes albiannulata* McD. Medicine Hat, Alta.
Habrophlebia vibrans Needh. (*jocosa* Banks). Covey Hill, Que.; Algonquin Park, Ont.
Habrophlebiodes americana Banks (*betteni* Needh.). Hemmingford, Covey Hill, Hull, Que.
Ephemerella temporalis McD. Fredericton, N.B.; Covey Hill, Aylmer, Hull, Que.; Ottawa, Algonquin Park, Ont.
Ephemerella bicolor Clem. Laprairie, Que.; Ottawa, Go Home Bay, Ont.
Ephemerella lutulenta Clem. Hull, Que.; Ottawa, Go Home Bay, Ont.
Ephemerella lineata Clem. Go Home Bay, Ont.
* *Ephemerella tibialis* McD. Banff, Alta.
* *Ephemerella atrescens* McD. Covey Hill, Laprairie, Lachine, Hull, Que.; Ottawa, Ont.
* *Ephemerella sordida* McD. Lachine, Hull, Que.
Ephemerella serrata Morg. Hull, Que.; Ottawa, Ont.
* *Ephemerella simplex* McD. Laprairie, Que.
* *Ephemerella attenuata* McD. Hull, Que.
The four starred preceding species are described in the Can. Ent., Vol. LVII, February, 1925.

Ephemerella fuscata Wlk. (*walkeri* Eaton). Laprairie, Hull, Que.; Ottawa, Ont.
Ephemerella excrucians Walsh. Kingston, Ont.
Ephemerella inermis Eaton. Waterton Park, Alta.; Nicola, B.C.
* *Ephemerella infrequens* McD. Waterton Park, Alta.
Ephemerella dorothea Needh. Covey Hill, Que.
Ephemerella invaria Wlk. Covey Hill, Que.
* *Ephemerella norda* McD. Nordegg, Alta.
Caenis diminuta Wlk. (?). Ft. Coulonge, Que.
Several species of this genus occur in Canada but as yet they have not been worked over.
Tricorythodes atra McD. Wakefield, Que.
Baetis dardanus McD. Lachine, Que.; Ottawa, Ont.; Aweme, Man.
Baetis pygmaea Hag. (*propinquus* McD. nec Walsh). Ottawa, Ont.
Baetis intercalaris McD. Wakefield, Hull, Que.; Ottawa, Ont.; Aweme, Man.
Baetis phoebus McD. Hull, Que.; Ottawa, Kingston, Ont.
Baetis flavistriga McD. Wakefield, Hull, Que.; Ottawa, Ont.
Baetis nanus McD. Ottawa, Ont.
Baetis parallela Banks (?). Nicola, Oliver, B.C.
Baetis intermedius Dodds (?). Waterton Park, Alta.
Beatis tricaudatus Dodds. Salmon Arm, B.C.
Baetis moffatti Dodds. Waterton Park, Moraine Lake, Alta.
Baetis parvus Dodds. Waterton Park, Alta.
Heterocloeon curiosum McD. Wakefield, Hull, Que.; Ottawa, Ont.
* *Pseudocloeon turbidum* McD. Wateron Park, Alta.
Pseudocloeon carolina Banks. Covey Hill, Que.
Pseudocloeon virilis McD. Hull, Que.; Ottawa, Ont.
Pseudocloeon chlorops McD. Ottawa, Ont.
Pseudocloeon punctiventris McD. Hull, Que.; Ottawa, Ont.
Pseudocloeon dubium Walsh. Ottawa, Ont.; Aweme, Man.
Centroptilum fragile McD. Aylmer, Hull, Que.; Ottawa, Ont.
* *Centroptilum ozburni* McD. Hull, Que.; Ottawa, Ont.
* *Centroptilum simile* McD. Covey Hill, Que.
* *Centroptilum bellum* McD. Aylmer, Hull, Que.
* *Centroptilum infrequens* McD. Winnipeg, Man.
* *Centroptilum rufostrigatum* McD. Aweme, Darlingford, Man.
* *Centroptilum bifurcatum* McD. Waterton Park, Alta.
Cloeon rubropicta McD. Hull, Que.; Ottawa, Go Home Bay, Lake of Bays, Ont.
Cloeon ingens McD. Douglas, Man.; Nordegg, Banff, Alta.
* *Cloeon inanum* McD. Waterton Park, Alta.
Callibaetis semicostata Banks. Stoney Mt., Teulon, Man.
Callibaetis pallidus Banks. Aweme, Man.; Saskatoon, Sask.
Callibaetis americanus Banks. Aweme, Man.
Callibaetis coloradensis Banks (*fusca* Dodds). Fredericton, N.B.; Kaslo, B.C.
Callibaetis tessellatus Hag. Waterton Park, Banff, Alta.; Kaslo, Rèvelstoke, Keremeos, Nicola, Oliver, B.C.
Baetisca rubescens Prov. Laprairie, Que.
Isonychia bicolor Wlk. Lachine, Hull, Que.; Ottawa, Algonquin Park, Ont.
Isonychia sicca Walsh. Treesbank, Aweme, Man.; Saskatoon, Sask.
Ameletus ludens Needh. Hull, Que.
Ameletus subnotatus Eaton. Lethbridge, Alta.
Ameletus validus McD. Banff, Alta.
* *Ameletus vernalis* McD. Oliver, B.C.
Ameletus velox Dodds. Waterton Park, Moraine Lake, Alta.
Siphlonuroides croesus McD. Ottawa, Ont.
Siphlonuroides midas McD. Ottawa, Ont.
Siphlonurus quebecensis Prov. (*triangularis* Clem). Wakefield, Que.; Ottawa, Ont.
Siphlonurus berenice McD. Covey Hill, Cascades, Que.
Siphlonurus alternatus Say. Fort Norman, N.W.T.; Wakefield, Hull, Que.; Ottawa, Ont.
Siphlonurus occidentalis Eaton. Waterton Park, Banff, Moraine Lake, Alta.
Siphlonurus phyllis McD. Douglas, Man.; Banff, Alta.
Metretopus novegicus Eaton. Slave Lake, Alta.

Heptagenidae

Siphloplecton basalis Wlk. (*flexus* Clem.). Fredericton, N.B.; Wakefield, Megantic, Hull, Que.; Ottawa, Go Home Bay, Ont.
Siphloplecton interlineata Walsh. Aweme, Man.
Iron longimanus Eaton. Waterton Park, Nordegg, Alta.
Iron pleuralis Banks. Covey Hill, Que.
* *Iron albertae* McD. Waterton Park, Alta.
* *Iron grandis* McD. Waterton Park, Alta.; Hedley, B.C.

Iron humeralis Morg. Covey Hill, Hull, Que.; Ottawa, Ont.
Iron fragilis Morg. Kentville, N.S.
Cinygma mimus Eaton. Waterton Park, Nordegg, Alta.
* *Cinygma confusa* McD. Waterton Park, Moraine Lake, Alta.
Cinygma ramaleyi Dodds. Banff, Alta.
* *Cinygma hyalina* McD. Waterton, Banff, Moraine Lakes, Alta.
* *Cinygma deceptiva* McD. Banff, Alta.
* *Cinygma atlantica* McD. Kentville, N.S.
Cinygma bipunctata McD. Covey Hill, Que.
Ecdyonurus carolina Banks. Covey Hill, Que.
Ecdyonurus frontalis Banks. Hull, Que.; Ottawa, Go Home Bay, Ont.
Ecdyonurus interpunctatus Say (*flaveola* Pict.). Ottawa, Ont.
Ecdyonurus canadensis Wlk. Covey Hill, Hull, Que.; Ottawa, Ont.; Aweme, Man.
Ecdyonurus tripunctatus Banks. Aylmer, Hull, Que.; Ottawa, Kingston, Algonquin Park, Ont.
Ecdyonurus fuscus Clem. Covey Hill, Montreal, Hull, Que.; Ottawa, Go Home Bay, Ont.
Ecdyonurus vicarius Wlk. Covey Hill, Hull, Que.; Ottawa, Caradoc, Ont.
Ecdyonurus luteus Clem. Laprairie, Hull, Que.; Ottawa, Go Home Bay, Ont.
Ecdyonurus terminatus Walsh. Aweme, Man.
Ecdyonurus rubromaculatus Clem. Hull, Que.; Ottawa, Go Home Bay, Ont.
* *Ecdyonurus lyriformis* McD. Banff, Alta.
Heptagenia flavescens Walsh. Aweme, Man.
* *Heptagenia reversalis* McD. Aweme, Man.
Heptagenia pullus Clem. Covey Hill, Montreal, Que.; Kingston, Go Home Bay, Ont.
Heptagenia lucidipennis Clem. Hull, Que.; Ottawa, Orillia, Go Home Bay, Ont.
* *Heptagenia inconspicua* McD. Aweme, Treesbank, Wawanesa, Man.
Heptagenia marginalis Banks. Hull, Que.; Ottawa, Ont.
Heptagenia maculipennis Walsh. Aweme, Treesbank, Man.
* *Heptagenia juno* McD. Covey Hill, Que.
* *Heptagenia minerva* McD. Hull, Que.; Ottawa, Lake of Bays, Ont.
* *Heptagenia hebe* McD. Covey Hill, Lachine, Hull, Que.; Ottawa, Lake of Bays, Ont.; Aweme, Husavick, Man.
* *Heptagenia elegantula* Eaton (*coxalis* Banks, **querula* McD.). Aweme, Treesbank, Man.; Osoyoos, Oliver, B.C.
* *Heptagenia simplicioides* McD. Waterton Park, Alta.
* *Heptagenia solitaria* McD. Waterton Park, B.C.
* *Heptagenia adaequata* McD. Saskatoon, Sask.; Cowley, Lethbridge, Alta.
Heptagenia jejuna Eaton (*fusca* Wlk.). Fort Wrigley, N.W.T.; Waterton Park, Nordegg, Alta.

*Species marked thus are descrbed in Can. Ent., Vol. LVI, pp. 90-98, 113-122, 128-133, 221-226, 1924.

Orthoptera

Labiduridae
Labia minor L. Lincoln Co., Ont., (W. G. Garlick).

Tryxalinae
Orphalella speciosa Scud. Aweme, Man., (Criddle, White and Bird); Wawanesa, Man., (White).

Oedipodinae
Trimerotropis azurescens Brun. Lethbridge, Alta., (N. Criddle).
Trimerotropis salina McN. Orion, Alta., (Criddle and Seamans); Banff, Alta., (C. B. Garrett).
Trimerotropis agrestis McN. Orion, Alta., (Criddle and Seamans).

INDEX

PAGE

Aglaope trifasciata . . . 25
Agriolimax agrestis . . . 87
Agriotes mancus . . . 87
Agrotis fennica . . . 86
Alsophila pometaria . . . 84
Altica chalybea . . . 23, 86
" *ignita* . . . 23
" *woodsi* . . . 23
Alypia octomaculata . . . 12
Amphorophora lactucae . . . 86
Anisota senatoria . . . 87
Anthonomus signatus . . . 86
Anthrenus scrophulariae . . . 88
Anuraphis roseus . . . 84
Aphids . . . 11, 12
Aphis pomi . . . 84
Apple aphids . . . 84
" maggot . . . 10, 85
Arctiid caterpillars . . . 10
Ascogaster carpocapsae Vier . . . 84
Asilidae . . . 27
Asilus erythrocnemius Hine . . . 27
" *sadyates* Walk . . . 27
" *notatus* . . . 27
" *novaescotiae* Macq . . . 27
" *paropus* Walk . . . 27
" *snowi* Hine . . . 27
Asparagus beetle . . . 10
Aspidiotus perniciosus . . . 84
Attagenus piceus . . . 88
Baltimore butterfly . . . 87
Bark miner of apple . . . 85
Bean maggot . . . 12
Bee-fly . . . 14
Birch leaf skeletonizer . . . 8
Blackberry leaf miner . . . 86
Black cherry aphis . . . 13, 85
Blister beetles . . . 14
Buccalatrix canadensisella Chamb . . . 8
Cabbage butterfly . . . 9
" maggot . . . 9, 12, 86
" white . . . 12
Caliroa cerasi . . . 85
Camnula pellucida Scudd . . . 13
Canker worms . . . 84
Carabid beetle . . . 14
Carpet beetles . . . 88
Carpocapsa pomonella Linn . . . 9, 10
Carrot rust fly . . . 9
" worm . . . 12
Chelifer . . . 10
Cherry fruit-flies . . . 85
Cicadas . . . 8
Cigarette beetle . . . 9
Clothes moth . . . 88
Clover seed midges . . . 11
Codling moth . . . 9, 10, 12, 84
Contarinia johnsoni . . . 86
Cosmopolite butterfly . . . 87
Crioceris asparagi . . . 10
Cryptorhynchus lapathi Linn . . . 8
Cucumber beetles . . . 12
Currant aphids . . . 86
Currant fruit fly . . . 86
Cutworms . . . 11, 86
Cydia pomonella . . . 84

PAGE

Cyrtopogon falto Walk . . . 27
Datana integerrima . . . 10, 87
" *ministra* . . . 10
Diabrotica vittata . . . 10, 87
Diacrisia virginica . . . 10
Diapheromera femorata Say . . . 8
Dichelonycha subvittata . . . 13
Empoasca mali . . . 87
Epochra canadensis . . . 86
Erythroneura comes . . . 86
" *tricincta* . . . 86
Euchaetias egle . . . 10
Eulecanium nigrofasciatum . . . 88
Euphydryas phaeton . . . 87
European apple sucker . . . 63
European corn borer . . . 10, 12, 47, 50, 53, 54, 56, 57
European red mite . . . 85
Exeristes roborator Fab . . . 55, 58
Fall webworm . . . 8, 10
False scorpion . . . 10
Forest tent caterpillar . . . 8
Four lined leaf bug . . . 12
Frit fly . . . 8
Gipsy moth . . . 60
Gracilaria syringella Fabr . . . 8, 19, 87
Grape berry moth . . . 86
" blossom midge . . . 86
" leaf hoppers . . . 86
" vine flea-beetle . . . 86
Grasshoppers . . . 8, 13
Green apple bug . . . 63
Habrobracon brevicornis Wesm . . . 55, 58
Halisidota harrisii . . . 10
" *maculata* . . . 10
" *tesselaris* . . . 85, 10
Harlequin milkweed caterpillar . . . 10
Heel fly . . . 13
Hessian fly . . . 12
Housefly . . . 88
Hylemyia antiqua . . . 86
" *brassicae* Bouche . . . 9
Hypera punctata . . . 10
Hyphantria textor Harris . . . 8
Hyphantria . . . 10
Isia isabella . . . 10
Ithycerus novaboracensis . . . 13
Larch sawfly . . . 9
Lasioderma sericorne Fab . . . 9
Leaf miner . . . 10
Lesser clover weevil . . . 71
Lesser grapevine flea-beetle . . . 23
Lilac leaf miner . . . 8, 19, 87
Lixus concavus . . . 12
Long-winged Rocky Mountain locust . . . 13
Lycophotia scandens . . . 86
Lygaeonematus erichsonii Hartgn . . . 9
Lygidea mendax . . . 85
Lygus caryae . . . 86
Lygus communis var. *novascotiensis* Kgt . . . 63
Lygus pratensis Linn . . . 9
Macrodactylus subspinosus . . . 86
Malacosoma disstria Hubn . . . 8
Maple leaf cutter . . . 8
Marmara elotella . . . 85

	Page
Melanoplus atlanis Riley	8, 14
" *brevittatus* Say	8
" *femur rubrum* de Geer	8
" *spretus* Uhl	13
Metallus bethunei	86
Microphthalma phyllophagae Curran	25
Mites	27
Monochamus scutellatus Say	8
Musca domestica	88
Muscina stabulans Fallen	28
Myzus cerasi	85
" *ribis*	86
Nepticula pomivorella	10, 67
Oberea bimaculata Oliv	9
Onion maggot	86
Ophyra leucostoma	28
Orthoptera	8
Oscinis variabilis Lw	8
Paleacrita vernata Pack	8
Papaipema cataphracta	12
" *nitela*	87
Paraclemensia acerifoliella Fitch	8
Paratetranychus pilosus	85
" *ununguis*	88
Parsnip webworm	12
Pea weevil	12
Pear pyslla	80, 85
" slug	85
Pegomyia hyoscyami	87
Pelecinus polyturator Drury	25
Percosia obesa Say	14
Phorbia brassicae	86
Phyllophaga anxia	24
Phyllophaga	87
Phytonomus nigrirostis	71
Pieris rapae Linn	9, 10, 75
Pissodes strobi Peck	9
Plum curculio	13
Polychrosis viteana	86
Porosagrotis orthogonia Morr	76
Potato beetles	12
" flea beetle	12
" leaf hopper	12, 87
Psilia rosea Fabr	9
Psyllia mali Schmid	63
" *pyricola*	85
Ptinus fur L	28
" *villiger* Reit	28

	Page
Pyrausta nubilalis Hubn	10, 12, 50, 53, 56
Radish maggot	12
Raspberry cane borer	9
Red bug	85
Red spiders	14
Rhagoletis cingulata	85
" *fausta*	85
" *pomonella*	10, 85
Rose chafer	13, 16, 86
Round-headed apple-tree borer	85
San Jose scale	12, 84
Saperda candida	76, 85
Sarcophagid flies	14
Scelio calopteni Riley	14
Seed corn maggot	12
Serica serica	13
Serpentine leaf miner	67
Slugs	87
Spinach leaf miner	87
Spring oakworm	87
Spring canker worm	8
Spruce bud-worm	9
Spruce mite	88
Stalk borer	87
Strawberry flea-beetle	23
" weevil	86
Striped cucumber beetle	10, 87
Systoechus vulgaris	14
Tarnished plant bug	9, 12
Terrapin scale	88
Tinea biselliella	88
Tiphia inornata Say	24
Tomato worm	12
Tortrix fumiferana Clemens	9
Trialeurodes vaporariorum	88
Trombidium	14
Vanessa cardui	87
Walking-stick insect	8
Walnut caterpillar	87
Wheat midge	12
White flies	88
White grubs	87
White grub saprophytes	28
White pine weevil	9
White spotted sawyer	8
Willow borer	8
Wireworms	11, 87
Yellow or dusky tussock moth	85

ONTARIO DEPARTMENT OF AGRICULTURE

FIFTY-SIXTH ANNUAL REPORT

OF THE

Entomological Society

OF ONTARIO

1925

PRINTED BY ORDER OF
HON. J. S. MARTIN, Minister of Agriculture

UT INCEPIT FIDELIS SIC PERMANET
ONTARIO

TORONTO
Printed by Clarkson W. James, Printer to the King's Most Excellent Majesty
1926

PRODUCED BY
The
United Press
LIMITED
TORONTO
CANADA

CONTENTS

PAGE

Officers for Year 1925-26 4
Financial Statement 4
Annual Meeting 5
Report of the Council 5
Report of the Montreal Branch 6
Report of the British Columbia Branch 7
Report of Insects for the Year 1925:
Division No. 1, Ottawa District: C. B. Hutchings 7
Division No. 3, Toronto District: A. Cosens 9
Division No. 6: H. F. Hudson, Strathroy 11
Insects of the Season in Ontario: L. Caesar and W. A. Ross 13
Notes on the Control of the Grape Berry Moth: William A. Ross 17
The Rose Scale in British Columbia: W. Downes 19
The Oriental Peach Moth in Canada: Arthur Gibson 22
Derris as an Insecticide: Arthur Kelsall, J. P. Spittall, R. P. Gorham and G. P. Walker 24
Miscellaneous Notes on Lubricating Oil Sprays with Special Reference to their use for Pear Psylla Control: William A. Ross 40
The Distribution of Insects and the Significance of Extralimital Data: E. P. Felt 44
Observations in Quebec in 1925: Prof. Georges Maheux 48
Insect Pests Imported on Miscellaneous Plant Products: R. A. Sheppard 50
Some Insects and Entomologists: W. E. Britton 55
Controlling the Brown Tail Moth in Nova Scotia: F. C. Gilliatt 63
The Gipsy Moth Situation in Quebec: L. S. McLaine and S. H. Short 67
The Birch Leaf Skeletonizer (*Buccalatrix canadensisella* Chamb.): C. B. Hutchings 69
A Preliminary Announcement on the Outbreak of the European Pine Shoot Moth: L. S. McLaine 71
Mortality of the European Corn Borer (*Pyrausta nubilaris* Hubn.) Adults and Larvae: L. Caesar 72
The Spread and Degree of Infestation of the European Corn Borer in 1925: W. N. Keenan 75
Recent Developments in the Introduction of Parasites of the European Corn Borer in Ontario: A. B. Baird 78
Egg Studies of the Clover Leaf Curculio (*Sitones lispidulus* Fab.): H. F. Hudson .. 79
The Striped Cucumber Beetle (*Diabrotica vittata* Fab.): James Marshall 80
Garden Insects of 1925 in Montreal District: Lionel Daviault 83
Parasites of White Grubs in Southern Quebec. A Progress Report: C. E. Petch and G. H. Hammond 85
Notes on the Life and History of the Clover Leaf Borer (*Hylastinus obscurus*): H. F. Hudson 92
The Entomological Record, 1925: Messrs. Criddle, Curran, Viereck 94
Index 108

Entomological Society of Ontario

OFFICERS FOR 1925-26

President—REV. FATHER LEOPOLD, La Trappe, Que.

Vice-President—PROF. A. W. BAKER, B.S.A., O. A. College, Guelph.

Secretary-Treasurer—R. OZBURN, O. A. College, Guelph.

Curator and Librarian—J. A. FLOCK, O. A. College, Guelph.

Directors—Division No. 1, C. B. HUTCHINGS, Entomological Branch, Dept. of Agriculture, Ottawa; Division No. 2, C. E. GRANT, Orillia; Division No. 3, DR. A. COSENS, Toronto; Division No. 4, F. J. A. MORRIS, Peterborough; Division No. 5, DR. J. D. DETWILER, Western University, London; Division No. 6, H. F. HUDSON, Strathroy; Division No. 7, W. A. ROSS, Vineland Station.

Directors (ex-Presidents of the Society)—REV. PROF. C. J. S. BETHUNE, Toronto; PROF. JOHN DEARNESS, London; PROF. WM. LOCHHEAD, Macdonald College, Que.; JOHN D. EVANS, Trenton; PROF. E. M. WALKER, University of Toronto; ALBERT F. WINN, Westmount, Que.; PROF. LAWSON CAESAR, O. A. College, Guelph; ARTHUR GIBSON, Dominion Entomologist, Ottawa; DR. J. H. SWAINE, Entomological Branch, Ottawa.

Editor of "The Canadian Entomologist"—DR. J. McDUNNOUGH, Entomological Branch, Ottawa.

Delegate to the Royal Society of Canada—THE PRESIDENT.

FINANCIAL STATEMENT

FOR THE YEAR ENDING OCTOBER 31ST, 1925

Receipts		*Expenditures*	
Cash on hand, 1924	$458 83	Printing	$1,418 57
Subscriptions	559 08	Salaries and honoraria	250 00
Membership dues	83 90	Expense	64 35
Advertisements	145 68	Library	3 36
Back numbers	60 93	Annual Meeting	93 66
Bank interest	7 24	Exchange	17 45
Government grant	1,000 00	Balance cash on hand	468 27
	$2,315 66		$2,315 66

By cash on hand	$468 27
To printing account payable	115 00
Net balance	$353 27

Respectfully submitted,

Auditors—L. CAESAR
J. A. FLOCK.

A. W. BAKER,
Secretary-Treasurer.

Entomological Society of Ontario

ANNUAL MEETING

The sixty-second annual meeting of the Ontario Entomological Society was held in the offices of the Dominion Entomological Branch, Birks Building, Ottawa, November 27th and 28th, 1925, the following members being present: A. B. Baird, Chatham, Ont.; A. W. Baker, Guelph, Ont.; A. B. Bigelow, Toronto, Toronto, Ont.; J. K. Breitenbecher, Montreal, Que.; Dr. W. E. Britton, New Haven, Conn.; P. I. Bryce, Ottawa; J. W. Buckle, Montreal, Que.; Prof. L. Caesar, Guelph, Ont.; Dr. A. T. Charron, Ottawa; N. Criddle, Ottawa; C. H. Curran, Ottawa; Lionel Daviault, McDonald College, Que.; M. B. Davis, Ottawa; J. J. de Gryse, Ottawa; Prof. J. D. Detwiler, London, Ont.; A. G. Dustan, Ottawa; Arthur Finnamore, St. John, N.B.; H. S. Fleming, Ottawa; Dr. Norma Ford, Toronto, Ont.; W. A. Fowler, Toronto, Ont.; Mr. Arthur Gibson, Ottawa; Mr. F. C. Gilliatt, Annapolis Royal, N.S.; R. P. Gorham, Fredericton, N.B.; F. Hennessey, Ottawa; H. F. Hudson, Ottawa; C. B. Hutchings, Ottawa; L. E. James, St. Thomas, Ont.; Fritz Johansen, Ottawa; W. N. Keenan, Ottawa; Arthur Kelsall, Annapolis Royal, N.S.; F. H. Kitto, Ottawa; Prof. Brooker Klugh, Kingston, Ont.; Hoyes Lloyd, Ottawa; Mr. F. A. Herman, Ottawa; Mr. W. T. Macoun, Ottawa; Mr. Georges Maheux, Quebec, P.Q.; Mr. Grant Major, Ottawa; Mr. Jas. Marshall, Guelph, Ont.; Prof. A. N. Miller, Ottawa; Mr. Frank Morris, Peterborough, Ont.; Dr. J. H. McDunnough, Ottawa; Mr. D. A. McKay, Ottawa; Mr. L. S. McLaine, Ottawa; Mr. E. A. McMahon, Montreal, Que.; Mr. Chas. McNamara, Arnprior, Ont.; Mr. R. H. Painter, Ottawa; Mr. C. E. Petch, Hemmingford, Que.; Mr. A. Richardson, Ottawa; Mr. W. A. Ross, Vineland Station, Ont.; Mr. W. Ryan, Montreal, Que.; Mr. R. W. Sheppard, Niagara Falls, Ont.; Mr. S. H. Short, Ottawa; Dr. J. M. Swaine, Ottawa; Mr. C. S. Thompson, Chatham, Ont.; Mr. C. R. Twinn, Ottawa; Prof. N. C. Van Duzee, Buffalo, N.Y.; Mr. H. L. Viereck, Ottawa; Dr. E. M. Walker, Toronto, Ont.; Mr. George Wishart, Arnprior, Ont.; Mr. C. H. Young, Ottawa.

REPORT OF THE COUNCIL

The Council of the Entomological Society of Ontario begs to present its report for the year 1924-25.

The sixty-first annual meeting of the Society was held at the Ontario Agricultural College, Guelph, on Thursday and Friday, November 27th and 28th, 1924.

The meeting was well attended by members of the Society from various provinces, by a number of American entomologists and other visitors. Rooms and board for members and visitors were arranged in the college buildings.

The morning and afternoon meetings were held in the lecture room of the Department of Entomology. The Thursday evening meeting was held in Memorial Hall when President Reynolds welcomed the members and visitors to the college, and Dr. C. L. Metcalfe delivered the public lecture on "Methods of Warfare Against Insects." Vocal solos by two young ladies of Macdonald Hall added to the programme.

After this meeting a smoker was held in the new faculty club room in the basement of Memorial Hall. Here the members and visitors were entertained by two students of the Ontario Agricultural College. The evening proved most enjoyable.

The programme was a full one. Many papers were presented, one morning session being devoted to the European corn borer.

Following is a list of the papers given at the meeting:

Lessons from the Grasshopper Outbreak of 1919-23 in Manitoulin—MR. N. CRIDDLE.
Recent Developments in Airplane Dusting—DR. J. M. SWAINE.
Farm Practices and Rose Chafer Control—MESSRS. W. A. ROSS and J. A. HALL.
The Lilac Leaf Miner, *Gracilaria syringella*—MR. G. B. HUTCHINGS.
The Occurrence of the Lesser Grapevine Flea-beetle in Canada—MR. ARTHUR GIBSON.
Sugaring—MESSRS. H. F. HUDSON and A. A. WOOD.
Notes on Insect Parasites of Phyllophaga spp. in Quebec—MR. C. E. PETCH.
Ptinus fur L., A Serious Pest of Flour in Western Canada—MR. C. H. CURRAN.
The Spread and Degree of Infestation of the European Corn Borer in Ontario in 1924—MR. W. N. KEENAN.
Mortality of European Corn Borer Larvae in the Early Instars—PROF. L. CAESAR.
Further Data on the Mortality of European Corn Borer Larvae—MR. R. H. PAINTER.
The Introduction of European Corn Borer Parasites into Ontario—MR. A. B. BAIRD.
The Cutting Box as a Factor in European Corn Borer Control—MR. G. A. FICHT.
The Campaign for General Control of the European Corn Borer in Ontario—MR. H. G. CRAWFORD and PROF. L. CAESAR.
The Discovery of the Gipsy Moth in Canada—MR. L. S. MCLAINE.
Some Methods of Teaching Entomology in the University of Illinois—DR. C. L. METCALFE.
A Study of the Methods Used in Growing Entomopthorus Fungi in Cages Prior to Their Artificial Dissemination in Orchards—MR. A. G. DUSTAN.
Notes on *Nepticula pomivorella*—MR. HAROLD FOX.
Notes on the Life History of the Lesser Clover Weevil, *Phytonomus nigrirostris*—MESSRS. H. F. HUDSON and A. A. WOOD.
Entomology in the Quebec Rural Schools—MR. GEORGE MAHEUX.
Observations on the Host Selection Habits of Phytophagous Insects with Special Reference to *Pieris rapae L.*—MR. C. R. TWINN.
The Pear Psylla Problem—MR. W. A. ROSS.
Insects of the Season in Ontario—MR. W. A. ROSS and PROF. L. CAESAR.

The Canadian Entomologist, the official organ of the Society, completed its fifty-six volume in December last. This volume contained 312 pages, illustrated by six full-page plates and seventeen text figures. The contributors to its pages numbered forty-nine and included writers in British Columbia, Alberta, Manitoba, Ontario, New Brunswick, Honolulu, and eleven of the United States.

REPORT OF THE MONTREAL BRANCH

The fifty-second annual meeting of this Branch was held on May 13th, 1925, in the Lyman Entomological Room, Redpath Museum, McGill University. Eight meetings were held during the season with an average attendance of five members. The following papers were read during the year:

Entomology as a Life Study .... GEO. A. MOORE
Genus Cymus .... GEO. A. MOORE
Gelastocoridae (Toad-shaped Bugs) .... GEO. A. MOORE
Saldidae (Shore Bugs) .... GEO. A. MOORE
Fertilization of Spiranthes romanzoffiana .... G. H. MOUSLEY
Marsh Treaders .... GEO. A. MOORE
Broad-shouldered Water Strider .... GEO. A. MOORE
Miridae .... GEO. A. MOORE
Naucoridae .... GEO. A. MOORE

The treasurer reported a balance on hand of $187.56.

The following were elected officers: President, Geo. A. Moore; vice-president, G. H. Hall; secretary-treasurer, J. W. Buckle; council—G. Chagnon, A. C. Sheppard and G. Fisk.

J. W. BUCKLE, *Secretary.*

REPORT OF THE BRITISH COLUMBIA BRANCH

The twenty-fourth annual meeting was held in the Hotel Vancouver, Vancouver, B.C., on the 14th February, 1925. The following papers were read:

Presidential Address	L. E. MARMONT
Pansy Spot of Apples	E. P. VENABLES
Lace Bugs of British Columbia	W. DOWNES
Insect Relations and Actions	PROF. G. J. SPENCER
Some Insect Galls of British Columbia	MISS DAVIDSON
Birds and Insects	W. B. ANDERSON
Why Plant Quarantine?	W. H. LYNE
Some Insect Problems in Vancouver	R. GLENDENNING
The Rose Scale	W. DOWNES

Election of officers resulted as follows: Hon. president, F. Kermode; president, L. E. Marmont; vice-president (coast), Prof. G. J. Spencer; vice-president (interior), E. P. Venables. Advisory Board: Messrs. Bannister, Downes, Hardy, Lyne, and Whittaker. Hon. secretary-treasurer, R. Glendenning, Agassiz, B.C.

Four new members were elected and the financial statement showed a balance of $176.55 at credit.

R. GLENDENNING, *Hon. Secretary-Treasurer.*

REPORT OF INSECTS OF THE YEAR 1925

DIVISION NO. 1, OTTAWA DISTRICT.—C. B. HUTCHINGS

I have pleasure in submitting herewith a list of some of the more important insects of the year 1925.

FIELD CROP AND GARDEN INSECTS

Cutworms were again numerous in 1925. An important outbreak of the black army cutworm occurred at Bowesville, Ont., near Ottawa. Garden produce suffered considerably from these pests.

Onion Maggot, *Hylemyia antiqua* Meig. Generally very plentiful throughout the whole district. Entire plots in some cases were wiped out. The average losses ranged from 25 to 60 per cent.

Twelve-spotted Asparagus Beetle, *Crioceris 12-punctata* Linn., was present but did little damage.

Carrot Rust Fly, *Psila rosae* Fab. This insect was very bad again this year throughout the district. Reports from the Central Experimental Farm, Ottawa, showed the fly was numerous and had done much injury to the plots there.

Colorado Potato Beetle, *Leptinotarsa decemlineata* Say. Numerous on all potato fields throughout the district.

Tarnished Plant Bug, *Lygus pratensis* Linn. While not so severe as last year, it nevertheless did a great deal of damage, especially to asters and dahlias; much loss was sustained by floriculturists and amateur gardeners due to imperfect blooms this insect causes as a result of its attack.

Four-lined Plant Bug, *Poecilocapsus lineatus* Fab., was present in flower gardens and did a moderate amount of damage.

Cabbage Maggot, *Hylemyia brassicae* Bouche. While this insect was present in many fields and gardens, its infestation was not above the average this season.

The Three-lined Potato Beetle, *Lema trilineata* Ol. A report from Meach Lake, in the Gatineau District, showed this pest was causing injury to potato crops during the earlier part of the summer.

Cabbage Worm, *Pieris rapae* Linn. On all cruciferous crops everywhere this insect was very troublesome. Crops were severely affected in the neighbourhood of Billings Bridge.

Slugs, *Agriolimax agrestis*. Garden slugs were exceptionally abundant throughout the season. More complaints were received about this trouble than from any field or garden insect. Tomatoes, cabbages and cauliflowers suffered particularly from their attack.

Shade Tree Insects

The Spring Cankerworm, *Paleacrita vernata* Peck, was abundant at Gatineau Point district, where it stripped many fine ash, maple and other shade trees.

The Green Fruit-Worm, *Graptolitha antennata* Walker, appeared in early summer in large numbers along the Ottawa river, opposite Rockcliffe, at Gatineau Point. It attacked severely many shade trees as well as shrubbery.

The Lilac Leaf Miner, *Gracilaria syringella* Fab., was particularly severe in its attack this year, specially towards the end of the summer in private gardens and roadside hedges.

The larva of the Imperial Moth, *Basilona imperialis* Drury, somewhat uncommon, was found in small numbers on white pine at Aylmer, Que.

The Privet Leaf Miner, *Gracilaria cuculipenellum* Hübn., was present again in Ottawa this summer in considerable numbers though not so severe as last year. It feeds on the *Amur privet, Legustrum amurense.*

The Maple Leaf Cutter, *Paraclemensia acerifoliella* Fitch, was noticeable on maples in and about Ottawa. There were many inquiries about the severe injury that it causes. It many cases the foliage was badly riddled and discoloured.

The Pine Sawfly, *Neodiprion lecontei* Fitch, was found in large numbers on young red and Austrian pines at Rockliffe, Ont. Many trees were badly defoliated and their leaders injured permanently.

Miscellaneous

Mosquitoes.—During April, mosquitoes were normally troublesome in and about Ottawa. Among the number of species to be found, the commonest were *Aedes stimulans*, *A. hursuteron* and *A. vexans*. On account, however, of the reduced flooding of the Ottawa and Rideau rivers brought about by a subnormal precipitation during the winter and spring, and also due to the principal breeding grounds being treated with oil, the mosquitoes were decidedly less troublesome this season in the Ottawa District than usually.

Division No. 3, Toronto District.—A. Cosens

While spending a vacation at Kincardine, I noticed that the Balm of Gilead trees along the beach were badly infested with two species of gall-producing aphids. The galls differed from any I had collected at Toronto. They were very numerous, sometimes each leaf of a large branch carried one or more galls.

One type of gall consists of a slight swelling of the blade of the leaf, along each side of the midrib. The leaf is folded with the under surface within. The gall starts usually at the base of the leaf and extends for about two-thirds of the length of the midrib.

The other type is sub-globular, produced usually from the end of the petiole at the base of the leaf. The galls project on the upper sides of the leaves, on which they are from one to four in number. Often two are paired, one on each side of the petiole. The galls open by slits on the under side of the leaves.

Dimensions: One-quarter to three-quarters inches in diameter.

There are the following six species of aphid galls common on poplars in the vicinity of Toronto.

Pemphigus bursarius L.

Host: *Populus nigra* var. *italica* Du Roi, *Lombardy Poplar.*

A somewhat cone-shaped gall produced from the leaf petiole of the host. Usually the petiole is somewhat flattened and much bent at the point of attachment of the gall. The opening of the gall is at the apex of the cone, which in most cases is slightly bent over.

Dimensions: Height of gall, three-eights to one-half inch.

Pemphigus populicaulis Fitch.

Host: *Populus deltoides* Marsh, *Cotton-wood.*

An irregularly spherical gall, located on the petiole of the leaf at the junction of the blade. It is produced by a widening and thickening of the petiole combined with a twisting of that organ in an almost horizontal plane. On the outside the gall is prominently ridged in the direction of the petiole.

Dimensions: Three-eighths inch in diameter.

Pemphigus populi-transversus Riley.

Host: *Populus deltoides* Marsh, *Cotton-wood.*

An ellipsoidal gall, varying in its position on the petiole of the leaf. It resembles the preceding species in combining a widening of the petiole with a frequent bending of the affected part. The orifice is a transverse slit, with slightly thickened lips, on the side of the gall opposite the petiole. The part of the gall wall formed by the petiole is ridged longitudinally.

Dimensions: One-half inch in longest diameter.

Pemphigus vagabundus Walsh.

Host: *Populus deltoides* Marsh, *Cotton-wood.*

All the leaf rudiments of the terminal bud appear to be concerned in the production of this gall. Yet it is in reality a large pouch-gall with its wall thrown into smaller secondary folds. The apex of the stem, from which the gall originates, usually is swollen to nearly twice its normal diameter. As the tips of the twigs, on which these galls occur, are killed, they often remain prominent objects on the trees for several years.

Dimensions: Two inches in diameter.

The two following galls are apparently undescribed:

Host: *Populus balsamifera* L.

A pouch-like gall on the under surface of the leaf, produced by a fold in the blade along the line of the midrib or a principal vein, to which one edge of the fold is attached. The slit-like opening, which is on the upper surface of the leaf, extends the full length of the gall.

Dimensions: One-half inch in length along line of attachment.

Host: *Populus balsamifera* L.

Necklace-like rows of globular to ellipsoidal leaf-fold galls, projecting from the upper surface of the leaf. They open by slit-like orifices on the under surface. On some leaves the galls extend to nearly their full length, and are arranged in two rows, one on each side of the midrib.

In the order Hemiptera, there are two families containing gall-makers, the *Aphididae* and *Psyllidae*. In the former are included the common aphids or plant lice; in the latter, insects that resemble these but are provided with a pair of jumping legs. The members of both these families are so easily recognized that they serve as a ready means for separating the Hemipterous from the other types of galls.

These galls vary from the simple, curled-leaf type to those with the several zones differentiated that are typical of the most complex *Dipterous* and *Hymenopterous* forms. From these the galls of the plant lice may be easily distinguished by the presence of an external orifice which enables the occupants to vacate the galls.

As I was out of the city during July and August, I have asked Mr. R. W. Blakely, superintendent of the Parks Department, to write a few notes for me concerning the insects most in evidence on the trees this summer. He has kindly sent to me the following:

"The larger moths and caterpillars did not seem to be as plentiful this season as usual. The tussock moths were fewer in numbers and did not develop so well as in other years. The tent caterpillars were also equally scarce.

The aphids were, however, more numerous. Especially was this true in the case of the species that attack the maples. I have never seen them worse than they were this year; on some streets the trees were half defoliated by them.

"We have had very few complaints this year about the elm bark louse or scale. Although it is still present in the city, it has been kept in check by spraying with oil emulsion.

"There are very few plane or sycamore trees in our city and I have always considered this species immune from insects. But while on a visit to Cleveland, Ohio, I noted that some fine avenues of these trees were badly infested with a scale larger than that on our elms. This pest seemed more destructive than ours as the smaller branches were covered with the scales and the leaves were much discoloured and falling.

"There was also an unusual condition on some Scotch elms at 426 St. Clair Avenue West. The insect was a leaf miner and in some instances covered entirely trees that were quite large. The leaves turned light yellow as though the trees were dead. When these were examined recently they did not seem to be much the worse.

"I wish also to note a severe outbreak of Buccalatrix at No. 10 Fernwood Park Avenue. There the red oaks were badly infested, but the pest seems not to be widespread as I have not seen it anywhere else."

Division No. 6.—H. F. Hudson, Strathroy

The season on the whole has been fairly favourable for insect activity, but outside of the extensive damage done by the European corn borer, and a decided increase of the potato leaf hopper in Middlesex county, insect activity has not been as marked as in recent years. The following insects have been noted:

Fruit Insects

Codling moth (*Carpocapsa pomonella*). Generally speaking, injury by this insect has not been as severe as in recent years. Much more efficient spraying has been done. In unsprayed orchards the insect was quite abundant.

Bud moth (*Tmetocera ocellana*). This was unduly abundant this year and appears to be on the increase. In unsprayed orchards considerable damage was inflicted.

Rose beetles (*Macrodactylus subspinosus*). While not quite as abundant as last year, considerable damage was done especially to the young green fruit, raspberries, etc.

Eight-spotted forester (*Alypia octomaculata*). Local grapevines were heavily infested by the larvae of this pest, but all larvae observed were heavily infested or parasitized by a species of tachinid.

Raspberry sawfly (*Monophadnus rubi*). Larvae of this sawfly were noted in small numbers in plantations in Elgin county.

Cherry slug (*Eriocampoides limacina*). Fairly common on cherry and pear trees.

Currant worm (*Pteronus ribesii*). Very abundant on red currant and gooseberry.

Plum curculio (*Conotrachelus nenuphar*). Quite abundant and destructive in the vicinity of Coldstream and Poplar Hill.

Humped apple caterpillar (*Schizura concinna*). A small outbreak of this insect occurred at Poplar Hill.

Vegetable Insects

Potato leaf hopper (*Empoasca mali*). This has been our most important vegetable pest. Early and medium-early potato fields that were not sprayed with bordeaux mixture suffered considerable loss. This insect is becoming our most important potato pest, and is increasing in abundance every year.

Corn ear worm (*Heliothis obsoleta*). Considerable injury was done to the early corn crop, especially in Essex county, by this pest. Reports indicate that some fields suffered a 50 per cent. loss.

Parsnip webworm (*Depressaria heracliana*). Unusually abundant this year, especially in the cow parsnip. More than usually abundant in Kent county.

Cabbage maggot (*Phorbia brassicae*). A slight local injury was occasioned by this insect, but few growers who care to take the risk were the only ones affected.

Onion maggot (*Phorbia ceparum*). Very little injury was noted this year, the crop appearing to be much freer than usual.

Onion thrip (*Thrip tabaci*). A slight injury was noted in the Leamington marshes and elsewhere, but no commercial loss was noted.

Potato stalk borer (*Papaipema cataphracta*). A few specimens of injured potato stalks were sent in for identification. The material was reared, and proved to be the above species.

Three-lined potato beetle (*Lema trilineata*). While not by any means injurious, this insect was much more abundant than usual.

Squash bug (*Anasa tristis*). Slightly more abundant than last year.

Flea beetles (*Epitrix sp.*). Quite abundant and in some turnip fields necessitated replanting, especially in Oxford county, around Cathcart and Burford.

Cabbage worm (*Pieris rapae*) was abundant, but less injurious than last year.

Cucumber beetles (*Diabrotica vittata and D. duodecimpunctata*). In some fields both species were injurious, while in others hardly a beetle could be found.

Live Stock Insects

The most important livestock insect of the season was the warble fly. A single specimen of H. bovis was taken at the stockyards.

Horn fly. A considerable number of complaints have been received relative to this insect. The pest is undoubtedly on the increase.

Shade Tree Insects

The outstanding feature of the year was the general widespread outbreak of the fall webworm (*Hyphantia sp.*). There was hardly a tree in the Government park at Point Pelee that was not heavily attacked. This condition was generally common throughout Western Ontario.

Walnut caterpillar (*Datana ministra*). Much less abundant than last year, but still fairly abundant.

Field Crop Insects

Cutworms. While fairly abundant this year, little damage was done. Before most of the cutworms had matured, a fungous disease attacked them. Considerable injury by these insects to the tobacco crop in Essex and Kent counties was received, but this could have been checked by timely applications of the poisoned bait.

Hessian fly (*Phytophaga destructor*). We have never known the wheat crop to be so free from this pest as it was this year. No injury of any kind was noted, except to a small field, but unfavourable weather during the flight of the flies apparently checked their increase.

June beetles (*Phyllophaga rugosa*). A very small flight of this species occurred in early June. No other species was observed.

Potato beetle (*Leptinotarsa decimlineata*). A heavy spring brood appeared, but the later brood was very light.

Grass spittle insect (*Cercopid sp.*). In low, moist land this insect was very abundant.

European corn borer (*Pyrausta nubilalis*). We have never had such an extensive destructive outbreak of this pest as occurred this year in Essex and Kent counties. Whole fields were entirely ruined. The general situation in western Ontario shows an increase of this pest.

INSECTS OF THE SEASON IN ONTARIO

L. Caesar, Ontario Agricultural College, Guelph
and
W. A. Ross, Dominion Entomological Laboratory, Vineland Station

The season of 1925 was not characterized by many outbreaks of injurious insects.

Orchard Insects

The Codling Moth (*Cydia pomonella*). While there was a considerable amount of "side-worm" damage in some commercial orchards in the Niagara and Burlington and some other districts, codling moth injury, on the whole, was somewhat less than usual in most of the apple-growing sections of Ontario.

San José Scale (*Aspidiotus perniciosus*). According to a report received from Norfolk county, the San José scale was quite conspicuous in apple orchards in the Courtland section. However, in most districts it made but little headway this year after the severe setback of 1924.

Apple Maggot (*Rhagoletis pomonella*). Many complaints regarding this insect were received from different parts of the province.

Spring Canker Worm (*Paleacrita vernata*). In many neglected apple orchards in Welland, Lincoln, Wentworth, Halton and Bruce counties, the trees were defoliated by canker worms. Some of these orchards have been defoliated now for at least three years in succession.

Apple Leafhoppers (*Empoasca fabae and Typhlocyba rosae*). The apple leafhopper (*Empoasca fabae*) was unusually abundant on apple trees almost all over the province, and in the Niagara district it was also common on plums, walnuts and raspberries. This species attacks and severely curls the young tender foliage of its host trees, and sometimes causes tip and marginal leaf burning, but unlike *Typhlocyba rosae* it produces no mottling. In so far as apples are concerned, *E. fabae* is primarily a pest of nursery stock and of young trees.

The rose leafhopper (*T. rosae*) was of no importance on apple trees, except in the Niagara district, where it was sufficiently abundant in some orchards to produce pallid foliage, and fruit (particularly Greening apples) specked with excrement. *T. rosae*, unlike the former species, feeds on the older leaves and produces a white mottling, but no distortion.

The European Red Mite (*Paratetranychus pilosus*). Last winter the eggs of this species were remarkably abundant on plum, apple and peach trees, much more numerous on peaches than ever before in our experience, but, in spite of this, there was no early outbreak of the mite. No appreciable injury on plum and apple trees was observed until August.

Apple Aphids (*Aphis pomi* and *Anuraphis roseus*). There were a few sporadic outbreaks of the green aphis (*Aphis pomi*) in the Niagara district and in western Ontario, but on the whole this insect was of very minor importance. It is a pleasure to record that Ontario orchards were also singularly free from rosy aphis injury.

Bud Moth (*Spilonota ocellana*). The work of the bud moth was rather conspicuous in some Norfolk apple orchards. In the case of some Spy apples which we examined, approximately sixteen per cent. of the fruit showed the characteristic injury.

The Fruit Tree Leaf Roller (*Archips argyrospila*). Even in orchards commonly subject to leaf roller attack, this pest was of minor importance.

Plant Bugs (*Miridae*). The species of mirids which attack the apple were unusually scarce throughout the province.

Cigar and Pistol Case Bearers (*Coleophora fletcherella* and *Coleophora malivorella*). In eastern Ontario these two species were sufficiently abundant in some unsprayed orchards to make the foliage ragged.

The Fall Webworm (*Hyphantria cunea*). The webs of this well-known insect were common in the Niagara district and eastern Ontario, but as usual the caterpillars caused no commercial injury in well-kept orchards.

The White-Marked Tussock Moth (*Hemerocampa leucostigma*). Characteristic tussock injury was quite readily found in some Niagara apple orchards, but it cannot be said that the moth caused any appreciable damage.

The Pear Psylla (*Psyllia pyri*). This insect was again injurious in the Niagara and Burlington districts.

The Pear Slug (*Eriocampoides limacina*). Cherry trees in Essex and Kent counties were defoliated by this slug, but, generally speaking, in the Niagara and other pear- and cherry-growing districts, it caused little injury—noticeable defoliation being largely confined to a few nurseries.

Oak and Hickory Plant Bugs (*Lygus quercalbae*, *L. omnivagus* and *L. caryae*). These plant bugs were again destructive in several Niagara peach orchards. In one orchard, where the oak species were particularly abundant, all the peach trees forty yards or less from the oaks were severely attacked, and approximately seventy per cent. of the fruit was rendered worthless. In this same orchard, affected fruit could be readily found one hundred yards from the oaks, but at this distance the damage was negligible.

Oriental Peach Moth (*Laspeyresia molesta*). As mentioned elsewhere, peaches infested with the Oriental peach moth were found at four points in the Niagara district, viz., St. David's, Peachland, Vineland Station and Bartonville.

Green Peach Aphis (*Myzus persicae*). In late May this aphis appeared in sufficiently large numbers on peach trees at St. David's and in other parts of the Niagara fruit belt to cause some alarm among fruit growers. The plant lice were largely confined to the inner and lower parts of the trees, and fortunately caused no commercial injury. In view of the fact that *M. persicae* does not remain long on the peach, it is very rarely necessary, under Ontario conditions, to combat it by spraying with an aphidicide.

The Lecanium Fruit Scale (*Lecanium corni*). This species was unusually prevalent on plums, particularly on Japanese varieties, in the Niagara peninsula.

Peach Twig Borer (*Anarsia lineatella*). Two peach orchards in the vicinity of St. David's were attacked by a twig-borer which we take to be *Anarsia lineatella*.

The Tarnished Plant Bug (*Lygus pratensis*). Plant-bug injury was unusually prevalent on peach nursery stock in the Niagara district. In one nursery the loss due to the killing of the terminal buds was estimated at $5,000.00.

Grape and Small Fruit Insects

The Grapevine Flea-Beetle (*Altica chalybea*). Last winter we advised grape growers that it was highly probable the grapevine flea-beetle would emerge from hibernation in destructive numbers. As we anticipated, the beetle appeared in outbreak form in vineyards along the foot of the escarpment, and in other parts of the peninsula. The majority of growers with infested vineyards sprayed their vines or handpicked the beetles, but in several graperies, where no steps were taken to combat the insect, it caused very severe injury.

Grape Leaf Hoppers (*Erythroneura comes* and *E. tricincta*). With favourable weather conditions, it is probable that grape-leaf hoppers will be injurious next year in some sections of the Niagara district. There was a marked increase in the leaf hopper population this season.

The Brown Grape Aphis (*Aphis illinoisensis*). In the Niagara fruit belt this plant louse was more common than ever before in our experience, on the tender growth of grapevines, but it was not responsible for any commercial damage.

The Grape Berry Moth (*Polychrosis viteana*). This insect was again injurious in several graperies in Grantham and Louth townships, Lincoln county.

The Grape Plume Moth (*Oxyptilus periscelidactylus*). This species, which is rarely troublesome in Ontario, was quite numerous in a Grimsby vineyard.

The Rose Chafer (*Macrodactylus subspinosus*). This pest was again abundant and destructive in several of the sandy sections of southern Ontario.

The Red Spider (*Tetranychus telarius*). During June there was a severe outbreak of red spider on raspberries in Lincoln, Wentworth, Halton, Norfolk, York, Middlesex and Oxford counties. In badly infested sections, the severe mite injury in conjunction with dry weather threatened to reduce the berry crop to a very serious extent, but fortunately this was largely prevented by frequent rains which fell during July and which invigorated the plants, and greatly prolonged the picking season. It is of interest to note that two years ago in the Niagara district, black currants were much more severely damaged by the red spider than raspberries were, whereas this season raspberries suffered the most.

The Strawberry Weevil (*Anthonomus signatus*). No serious weevil injury was noticed in strawberry patches this year.

The Blackberry Leaf Miner (*Metallus bethunei*). As usual this insect was present in blackberry patches in southern Ontario, but in all instances which came under our observation the leaf-mining damage was negligible.

The Raspberry Saw-Fly (*Monophadnoides rubi*). Saw-fly larvae were fairly common on raspberries in the Niagara district, but they caused no commercial damage.

Vegetable Insects

Beet Leaf Miner (*Pegomyia hyoscyami*). Spinach, beet, sugar beet and mangel leaves were seriously mined by this pest. In a number of cases spinach was so badly injured that it was ploughed under.

Onion Maggot (*Hylemyia antiqua*). There was considerable loss from the maggot in the great onion marsh around Point Pelee and in several other parts of the province, but apparently not more than usual. Some control work was done with lubricating oil emulsions, and, so far as a single year's experiments go, these new mixtures promise to give better results than any method previously used.

Cucumber Beetles (*Diabrotica vittata* and *D. 12-punctata*). The striped cucumber beetle was not particularly abundant this year. In the latter part of the season the 12-spotted beetle was much more numerous in Essex, Kent and Elgin counties than *D. vittata*.

European Corn Borer (*Pyrausta nubilalis*). For an account of this insect see elsewhere in this report.

STALK BORER (*Papaipema catafracta*). More than the usual number of specimens of this borer were sent in from various parts of the province, the sender usually thinking it was the corn borer. (There seems to be considerable confusion as to whether the species is *catafracta* or *nitela*. The only moths reared were *catafracta*).

CORN EAR WORM (*Chloridea obsoleta*). Towards the end of September and in October numerous samples of corn ears, infested with about half-grown larvae of this species, were received from widely separated parts of the province, some of them coming from as far north as New Liskeard and as far west as Kenora. The ear worm was more numerous this fall than in any year since the great outbreak of 1921.

CUTWORMS. The total loss from cutworms this spring was not exceptional, but there were a number of districts where there were small outbreaks, the most damage being done in New Ontario where the variegated cutworm (*Peridroma margaritosa*) and the black army cutworm (*Noctua fennica*) were the main species seen. The latter did considerable damage in some other districts to alfalfa and sweet clover.

WIREWORMS. Seldom have we received so many complaints of wireworm injuries as this year. The crop attacked in most cases was potatoes and as usual the ground had been broken up from sod only two years.

CABBAGE APHIS (*Aphis brassicae*) In several counties in southwestern Ontario turnips and cabbage were severely attacked by aphids. In some places, e.g. Waterloo county, whole fields of turnips were almost grey with them.

CARROT RUST FLY (*Psila rosae*). Carrots grown in towns and villages were severely attacked in many cases by this pest, to which perhaps too little attention has been given in the past.

SHADE TREES AND ORNAMENTALS

LILAC LEAF MINER (*Gracilaria syringella*). This comparatively new miner was active this year in several parts of the province, specimens having been received from Guelph, Acton, Toronto and Whitby, but it does not seem to have been so abundant on the whole as last year.

SPINY OAK WORM (*Anisota senatoria*). This year as last a considerable number of oak trees in western Ontario were defoliated by this caterpillar.

RED-HUMPED OAK OR MAPLE WORM (*Symmerista albifrons*). In parts of Bruce county this late-feeding caterpillar was quite abundant in maple woods. One woods visited on October 5th had been completely defoliated about two weeks before. The only caterpillars present at the time of the visit were the species just mentioned but whether they were the sole cause of the defoliation or not could not be determined.

MISCELLANEOUS

POWDER POST BEETLE (*Lyctus sp.?*). Specimens of the work of this insect, which is very destructive to sapwood, were received from Ayr, Hespeler, Rockwood, Locust Hill, Thamesford and Hamilton. In one case it was the posts of the barn that were attacked and another the rafters, and another the sleepers or sills. Either these insects are becoming more common than usual or more attention is being paid to them, for we have received a larger number of inquiries in regard to them the last two years than during the previous ten.

STABLE FLIES (*Stomoxys calcitrans*). This species of fly was remarkably abundant this fall and caused great annoyance to cattle and horses, especially in western Ontario. Human beings were also attacked in a most exasperating manner.

GRAIN MITE (*Tyroglyphus farinae*). This mite, identified by Dr. Ewing of the Bureau of Entomology, Washington, D.C., occurred in enormous numbers on a grain mixture intended for poultry. A few tests were made with paradichlorobenzene, carbon bisulphide, five per cent. carbolic acid, sulphur, hydrated lime and sodium fluoride, respectively. The last two had little or no effect but the paradichlorobenzene and carbon bisulphide killed very quickly. The five per cent. carbolic acid was also effective but was much slower and in many cases would, of course, be an impracticable remedy.

HOUSEHOLD PESTS. Clothes moths, carpet beetles, ants and bedbugs this year as usual were the subject of numerous inquiries from housewives.

HOUSE CRICKET (*Gryllus domesticus*). In Toronto there has been an unusual outbreak of this cricket. It was reported as getting into bakeries and kitchens where foods were stored and feeding on these.

CLOVER LEAF WEEVIL (*Hypera punctata*). The following interesting letter in regard to this insect was received from Windsor, Ontario, on September 1st: "Two or three weeks ago we had a shower of bugs over our business premises on a very hot day. When the bugs struck the roof some of them were alive, most of them dead. They have been lying around very thick ever since. The man who gathered these to send to you stated there were a million left. We do not know anything about the history of this particular animal, but have no doubt it would be of some interest to you." The letter is quoted because we have never heard of anything like this occurring in connection with this insect and as the writer was a member of a reputable firm we have no reason to believe that such an occurrence did not take place.

NOTES ON THE CONTROL OF THE GRAPE BERRY MOTH

WILLIAM A. ROSS, DOMINION ENTOMOLOGICAL LABORATORY, VINELAND STATION, ONTARIO

In recent years the grape berry moth, an insect which occurs sporadically in the Niagara fruit belt, and which generally is of minor importance, has come into prominence as a serious pest in several vineyards in Grantham and Niagara townships. During 1923 our attention was directed to a very severe outbreak of the insect in a large grapery near Virgil. According to the owner, berry moth injury first became conspicuous in 1919, but that season it was largely confined to the outside rows. However, during the next four years the whole vineyard was heavily infested, and the grapes were so seriously injured that many rows, even in the middle of the grapery, were left uncut. In 1921, the last year the grower attempted to dispose of the crop in the basket trade market, the pickers were required to pick off all the infested berries. This culling, in addition to the bunches left uncut, reduced the crop to a very serious extent, and also added very materially to the cost of harvesting.

Life History and Habits.—Before referring to the control experiments, a word should be said about the life history and habits of the moth. The winter is passed in the pupal stage in fallen leaves. The adults emerge in spring, and deposit their eggs on the blossom clusters, and later on the bunches of young grapes. The larvae—dark greenish or purplish caterpillars, about three-eighths inch long when full grown—web together and feed on the blossoms and newly set fruit, but fortunately, due to a heavy winter mortality, the first brood is generally not sufficiently abundant to cause any severe damage. When mature the caterpillars migrate to leaves, where they cut and curl over little flaps within which the cocoon is spun and the transformation to the pupal stage takes place.

The first brood is then followed by a second and much larger brood of caterpillars, which attack the green and ripening fruit. These larvae tie the fruit together with a few silken threads; bore into the berries; pass from one grape to another and feed inside on the pulp. Infested berries become discoloured and shrivelled and are absolutely worthless for any purpose.

Control.—In 1924 spraying experiments for the control of the berry moth were conducted in the aforementioned vineyard near Virgil, as follows:

Plot	Spray Materials	First Spray	Second Spray
1	Arsenate of lead............................1½ lbs. Sunoco oil..................................2 pints Bordeaux mixture..........................40 gals.	Immediately after blossoms.	About two weeks later.
2A	Arsenate of lead............................1½ lbs. Soap...1 lb. Bordeaux mixture..........................40 gals.	Immediately after blossoms.	About two weeks later.
2B	Same as 2A.	Immediately after blossoms.	About three weeks later.
3	Same as 1.	Immediately after blossoms.	About three weeks later.
4	Same as 1 and 3.	Immediately after blossoms.	None.

Check.—We should like to have had two fair size plots as checks, but as the owner was anxious to spray the whole vineyard, we had to satisfy ourselves with two unsprayed rows as a check—the outside rows of plot 1.

Method of Spraying.—The spray was applied by means of a power outfit with short rods and angle nozzles. Both sides of each row were sprayed, and care was taken to thoroughly cover every fruit cluster with the mixture.

Results.—The unsprayed vines became very badly infested with the berry moth, and by the time the grapes were cut, the fruit was so severely injured that it was absolutely worthless for any purpose, and, in fact, was not harvested. The sprayed vines, on the other hand, were remarkably free from serious damage —much more free than we expected to find them. The condition of the check, coupled with the fact that the berry moth was more troublesome in adjoining graperies than it was during the preceding season, would certainly indicate that spraying was the all-important, if not the only factor responsible for the remarkable decrease of the insect in the experimental plots.

The fruit from six vines in each plot was cut at practically the same time. Each bunch was carefully examined and the number of infested berries, number

of infested clusters, etc., were noted down. The results obtained in this manner are presented herewith in tabular form.

Plot	1	2A	2B	3	4	Check
Per cent. of infested bunches	6.74	7.69	10.22	16.19	19.32	99.17
Approximate per cent. of infested berries	0.57	0.69	0.94	1.63	1.85	47.21
Average number berries per infested bunch	3	2.80	2.98	3.53	3.40	16.90
Maximum number berries per infested bunch	9	6	9	11	11	47

On the basis of several examinations, which the owner of the vineyard and officers of the Dominion Entomological Laboratory made of rows here and there throughout the plots, we believe the above figures represent fairly accurately the average conditions in each plot. Before any of the fruit was harvested, we had satisfied ourselves that there was no serious injury in the sprayed plots, and that plot 1 had the smallest and plot 4 the largest percentage of infested bunches.

1925 Experiments.—This past season the whole vineyard was sprayed by the owner with arsenate of lead, soap and bordeaux mixture shortly after the blossoms, and the two rows which constituted our check in 1924 were given a second application two weeks later. An examination of the vines in plot 1 (plot 1, 1924) and in plot 5 C (check, 1924) afforded the following data:

Plot	5C	1
Per cent. of infested bunches	24	4.21
Approximate per cent. of infested berries	2.8	.39
Average number berries per infested bunch	3.58	3.19
Maximum number berries per infested bunch	10	6

On the basis of these experiments we are advising growers with berry moth infested vineyards to spray their vines with 1½ lbs. arsenate of lead powder, and 1 lb. soap in 40 gallons Bordeaux mixture, immediately after the blossoms, and, in the case of severe infestations, again two weeks later. We are emphasizing the importance of thoroughness in spraying, and the need of using liberal quantities of the spray material, so that all the fruit will be coated with it.

In so far as Ontario is concerned, we are of the opinion that with our present spraying machinery, it is essential to use short rods and angle nozzles for berry moth control. Any system of fixed nozzles, with which we are familiar, will not cover the vines sufficiently well to give satisfactory results.

THE ROSE SCALE IN BRITISH COLUMBIA

W. Downes

The Rose Scale (*Aulacaspis rosae L.*) has of recent years become a pest of cane fruits of some importance in the Hatzic-Mission district of the Fraser Valley, British Columbia. It is known to have been present in the district for about ten years and at first its occurrence occasioned no alarm, for the scale was slow in spreading and occured only in small numbers so that its effect upon the canes was inappreciable. Within the last four or five years, however, it has shown a sudden tendency to spread more rapidly and heavy infestations

have occurred, causing considerable loss to many growers. The area at present involved is small, extending from Mission to Hatzic in a belt approximately three miles long and half a mile wide.

When present in plantations of cane fruits the canes often become heavily encrusted with scales and the yield of fruit is greatly reduced, the leaf growth is stunted and the berries are small and hard. If the attack is severe the canes may be killed. Blackberries suffer severely from the scale and a moderate attack is sufficient to ruin the quality and quantity of the fruit, only small hard berries being produced which are difficult to pick. With raspberries, the Antwerp variety is attacked more severely than the Cuthbert. Loganberries are attacked but so far we have not found them as heavily infested as raspberries and blackberries. Curiously, the scale has not been found on wild blackberries and raspberries growing in the immediate neighbourhood. Other hosts of the Rose Scale that have been recorded are rose, dewberry, mango, myrtle, pear, sago palm and Tree of Heaven (*Ailanthus*).

Life History.—The Rose Scale is pure white in colour, the female scales being nearly circular in shape, slightly convex, light and thin in texture and loosely attached to their host. Slightly to one side are seen the exuviae shed at the first and second moults and forming the apparent head of the scale, and around them the waxy excretion forming the scale is built up in more or less concentric rings. Beneath the scale the female will be found, light red in colour and oval and grub-like in form. Around the body of the female there are usually numbers of minute reddish eggs and very often the empty eggshells of those hatched previously. The male scales are very different in appearance to the female; they are oblong and narrow in shape and tricarinate, with one central and two lateral ridges.

The winter may be passed in any stage from the egg to the gravid female, although the indications are that in British Columbia at any rate there is in some years an enormous winter mortality. This spring I have failed to find any live overwintered eggs but in ordinary seasons it is probable that some would survive. In exposed situations I failed this year to find many live overwintered scales in any stage, sometimes none at all. In sheltered places, on the other hand, live overwintered scales were numerous, 80 per cent. being alive. Very few of the living overwintered adult females had previously laid eggs; they were principally those that had matured just previous to going into hibernation. Females that had laid eggs the previous fall were practically all dead surrounded by numerous eggs and empty eggshells.

The overwintered females commence oviposition in late April or beginning of May, 30 to 50 eggs being laid and by the end of the month or beginning of June the first nymphs appear. Another batch of eggs is then laid which hatch early in July and then the overwintered mother scales of the first generation begin to die off, a few remaining alive until early in August. In the meantime the first brood hatching in the spring has matured and these commence oviposition in August. By September the young canes are heavily infested with scales of various ages. In October oviposition ceases and the scales begin to go into hibernation. According to my observations the scales require about two months to reach maturity.

The young nymphs or larvae are active little creatures, orange red in colour, oval in shape with short antennae and legs. Frequently they do not wander far in search of a suitable place to which to attach themselves but settle down round the older scales on the cane except when the cane is an old one and encrusted with scales, when they migrate to new growths.

There is a slight exudation of wax from the beginning but in the case of the female no very distinct scale formation until after the second moult. The second larval skin is added directly behind the first and then the nearly circular scale begins to be formed behind and around the two exuviae. In the case of the male the life history is somewhat different. After the first nymphal moult the elongate casing is formed directly behind the cast skin and completely surrounds the insect except at the head. The nymph having completed its growth, the next change is to a resting stage and in due time the male emerges, a minute, fragile, two-winged creature, without functional mouth parts, but with two pairs of eyes and only capable of living long enough to secure a mate.

The canes are infested principally within a foot or eighteen inches of the ground, and except when an infested cane happens to touch another few aggregations of scales will be found above that height. The favourite position taken up by the first arrivals on a young cane is at the base of a spine or at the nodes. After these spots are occupied the lower part of the cane becomes universally infested. A few scales have been found on the leaf petioles but this is rare.

The proportion of male and female scales on the canes varies enormously. On many canes 90 per cent. of the scales hatched during the late summer and early fall are males and canes have been seen densely covered with them. On the other hand some canes exhibit a great scarcity of males.

The duration of life of the individual female scale may be for the greater part of a year. Adult overwintered females collected in the middle of May were still alive at the middle of August. These females were probably hatched the previous September, completing their half growth before going into hibernation, so their duration of life had been about eleven months.

The number of eggs laid by the individual female has not yet been ascertained, but as many as 133 have been found beneath a female scale at one time.

Control Measures.—Notwithstanding the apparently fragile nature of this scale it has a reputation for being difficult to control and indeed our first experiences with it seemed to confirm this. In March, 1924, certain sprays were applied which ordinarily are considered effective against scale insects but the results were entirely unsatisfactory. These sprays were dormoil 1 to 16, kerosene emulsion 1 to 15, dry lime-sulphur 1 lb. to 4 gals. water, liquid lime-sulphur 1 to 9. The sprayed canes were examined on March 19th and again on April 30th and in no case was there evidence of more than partial control and the eggs did not appear to have been affected at all. There was a heavy mortality among the males but this was just as evident on canes that had not been sprayed and was no doubt due to natural causes. No further control measures were undertaken until the third week in August when a series of soap sprays were tried. These were: (1) Whale oil soap, one pound to one gallon of water; (2) Whale oil soap, half a pound to one gallon of water (warm); (3) half a pound of W.O. soap, B.L. 40 and three-quarters ounces water to one gallon; (4) half a pound of W.O. soap, Ialine, two ounces, water one gallon. "Ialine" is a creosol-soap spray of English manufacture. The old fruiting canes had previously been removed.

Examined on September 12th, the following results were found:

(1) Practically all scales and eggs killed. Control 99.5 per cent.

(2) Adults and eggs controlled. 97.4 per cent.

(3) Fairly good control of adults and eggs. 92.4 per cent.

(4) Good control of adults and eggs. 97.1 per cent.

About two gallons of spray are required for every thirty feet of row and the usual cost of the full strength is from 9 to 14 cents a gallon.

In order to reduce the cost of the spray further experiments were tried, using the same formulae both hot and cold. These were applied on September 29th. Notwithstanding the fact that heavy rain fell immediately after the sprays had been applied complete control was obtained with all the formulae. The half strength soap solution (half a pound to one gallon of water) applied hot gave practically as good control as the full strength applied cold (99.4 per cent).

The appearance of the scale when good control is obtained is distinctive. Live scales are plump and white whereas dead scales are usually shrunken and the insect turns brown and shows through the scale. The eggs also when sprayed with whale oil soap stick together in a mass whereas live eggs are always separate and are more or less powdered with the waxy excretion of the female. The effect of the spray is cumulative and canes should not be examined for control until at least a fortnight has elapsed.

At present we have no explanation to offer as to why spring applications are of doubtful value. Apparently the overwintered scales are more resistant. Further experiments were tried this spring and while in some cases fair control was obtained the results do not justify us in recommending spring spraying for this scale. In these experiments three kinds of miscible oil, whale oil soap and dry and liquid lime-sulphur were used. Although the applications were very thorough some of the rows on which they were applied show at the present time a moderate infestation of the scale whereas plots sprayed in the fall are practically clean.

Our present recommendations therefore are to cut out and burn the old fruiting canes as soon after the fruit is picked as is practicable and to spray the remainder with one pound of whale oil soap to one gallon of water or with half a pound of W.O. soap to 1 gallon of water applied hot. A driving spray should be used and the canes thoroughly wetted.

THE ORIENTAL PEACH MOTH IN CANADA

Arthur Gibson, Dominion Entomologist, Ottawa

I regret to add to the already long list of injurious insects found in Canada, an important enemy of peaches, namely the Oriental Peach Moth, *Laspeyresia molesta* Busck.

In the latter half of September, 1925, in peaches grown in the Niagara district, Ontario, I found living larvae near the centre of the fruits, which I determined as belonging to the genus *Laspeyresia* and most probably to the species *molesta*. In order to confirm the determination, larvae were forwarded to Dr. Alvah Peterson, in charge of peach insect investigations, United States Bureau of Entomology, who reported that they were undoubtedly those of the Oriental peach moth of the second and third instars.

Mr. W. A. Ross, in charge of our Vineland, Ont., laboratory, also found larvae in peaches grown in the immediate district of Vineland, Ont. He forwarded to me some specimens of moths taken in orchard bait pans on September 22nd to 25th, and these have been definitely determined by Dr. J. H. McDunnough as the Oriental peach moth. Mr. Ross reported further under date of October 14th, that he and his assistants had made a rough survey of the whole peach belt of the Niagara district, examining peaches at Queenston, Niagara-on-the-Lake, St. Catharines, Port Dalhousie, Peachland, Vineland Station, Beams-

ville, Grimsby Beach, Grimsby, Winona, Fruitland and Bartonville. This survey indicates that, if the insect is not generally distributed throughout the whole belt, it at least occurs in patches from Hamilton to the Niagara river. Larvae have been definitely found at Vineland Station, Queenston, Peachland and Bartonville.

Just when and how the pest was introduced into Ontario is not known, but in view of the numbers of larvae found in the Vineland district, the insect has doubtless been present for several years. Regarding its distribution, Wood and Selkregg state:* "If the infestation should extend to regions where fruit is extensively grown and shipped to other parts of the country, the distribution of the insect would almost certainly take place by transportation of the larvae, either in the fruit or in cocoons on the outside. There is danger, also, of disseminating the insect by shipping nursery stock bearing hibernating larvae. Without doubt it was in this way that it first entered the country and reached the localities where it is at present found. It may also spread for short distances from orchard to orchard by flight, as the moth is a strong flier at dusk and in the late afternoon on cloudy days.

Laspeyresia molesta was described by Busck in 1916† from material reared in the District of Columbia and environs. It was suggested at the time that the insect had "probably been accidentally introduced from Japan," and that it had been present in the District of Columbia for four or five years, or perhaps somewhat longer.

Since 1916, the insect has been found, in addition to the District of Columbia, in the following states of the United States: Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Indiana, Maryland, Mississippi, Missouri (?), New Jersey, New York, North Carolina, Pennsylvania, South Carolina (?) (twig injury noted), Tennessee and Virginia.

Food Plants.—In Ontario, as yet, the insect has only been found in the fruit of peach, but in the United States it is known to infest, in addition to peach, cherry, plum, apricot, several varieties of flowering cherries, quince, pear, apple and flowering quince.

Descriptions of the Insect.—The following descriptions of the various stages of the insect are taken from bulletin No. 405, by Guyton and Champlain, published by the Pennsylvania Department of Agriculture, June 1st, 1925.

The Eggs.—The eggs are about the size of a pinhead, transparent when empty or translucent and iridescent before hatching. They are circular in outline, scale-like, somewhat convex and with flattened edges. The centre is whitish or grayish with a slight polish. They hatch in from four to ten days.

The Larvae.—In general appearance the larvae or worms resemble the codling moth larvae, but are somewhat smaller, measuring about one-half inch in length when full grown. They vary in colour during the different stages of development; the younger larvae are a dirty cream color, varying to pink, which is intensified as they grow older.

The Pupae.—The pupae are yellowish brown in colour, smooth, with an average length of one-quarter of an inch. The pupal or quiescent period averages eight days, but may be more or less.

When the moth is ready to emerge the pupa pushes its way almost from the enclosing cocoon and attaches itself to the cocoon. The pupal case then splits and the moth emerges.

---

*Jour. Agric. Research, April, 1918. †Jour. Agric. Research, Nov., 1916.

The Adult or Moth.—The moth is somewhat smaller than the codling moth although resembling it in many respects. It has dusky brown mottled wings which are folded against the body when the moth is at rest. The wing spread is about three-eighths of an inch.

Regarding the habits of the larvae, the above authors state that in the State of Pennsylvania, the young larvae upon hatching immediately start out to find favourable breeding places in the terminals of fruit. The length of the time required for the larvae to develop fully is from eight to sixteen days, depending upon weather conditions.

There are four generations in the State of Pennsylvania. The first two generations of larvae feed mainly in the terminals of peach, cherry, and quince. A part of the third generation larvae are found in the terminals but very few individuals of the remaining generation enter the twigs. In one orchard where the trees were old and the twig growth slight, many of the larvae of the first generation went into the small peaches.

Larvae of the remaining generations feed in fruit, mainly peach, quince, and apple, the latter usually being attacked in the ripening condition and after the harvesting of peaches.

The full-grown larvae of the summer generations when leaving the fruit or stems to transform, prefer to form their cocoon on the sides or between the fruits, where they utilize the fuzz or hairs on the fruit together with their silk in making cocoons. Fruit baskets and corrugated board covers are also favourite places for pupation. Larvae of the third and fourth generations coming from picked fruit are found in such places, and this no doubt constitutes a means of spread of the moth.

The Control.—There is apparently no satisfactory method of control. In July, 1925, Mr. L. S. McLaine, Dominion Entomological Branch, visited Riverton, N.J., and discussed the habits of the Oriental peach moth with Dr. Peterson, who is in charge of the investigations for the U.S. Bureau of Entomology. In Dr. Peterson's opinion, nicotine sprays which have been recommended for the control of this insect are not practical owing to the number of sprays which would be necessary and which would render the cost too excessive even with the best of spraying to destroy the eggs. Only 25 per cent. approximately would, it is estimated, be destroyed, owing to the fact that the majority are laid on the underside of the leaves.

DERRIS AS AN INSECTICIDE

Arthur Kelsall, J. P. Spittall, R. P. Gorham, and G. P. Walker

Introduction

Several years ago the material now generally known as derris was used as an insecticide in a small way, at the Annapolis Royal Laboratory. At that time the results obtained were regarded as of scientific rather than of general interest from an economic standpoint, due to the fact that the price of the material appeared so large compared with that of other competitive insecticides. However derris became more widely used in England, apparently to quite an extent as an ingredient in proprietary insecticides, and coincidently the shrub from which the material is obtained was planted in quantity in the Malay States where it is now grown solely for the production of the insecticide. These

developments have very naturally brought this material to the forefront, and being now procurable in quantity at reasonable prices, it was decided to investigate the insecticidal properties of this material in some detail. In this paper, in which no review is made of the literature on this subject, is briefly described a summary showing typical results from the use of derris as an insecticide, together with a few general remarks on derris itself.

General Information on Derris

The insecticide is produced from plants of the Deguelia genus, many of which are highly poisonous, but the principal ones of commerce are apparently Deguelia elliptica and Deguelia uliginosa. This genus has been, and still is, commonly known as "Derris," from which obviously the insecticide takes its name, but the rules of botanical priority apparently require the use of the name Deguelia of Aublet. The genus extends over a large part of the tropics, Singapore, Sumatra, Java, Borneo, the Fiji and Philippine Islands, but its cultivation for insecticidal purposes is apparently mostly confined to the Federated Malay States. The plant is described as a low bush varying to a climbing plant with a short trunk and long trailing branches. It has an extensive root system, and it is from the roots that the insecticide is made. The roots, frequently known as "Tuba root," are dried and ground and the powder thus produced constitutes the insecticide, derris.

This root first interested Europeans as being a constituent of the arrow poison of the Malays and Borneo. The green root was macerated in water and the arrowheads alternately painted with the resulting fluid and dried in the sun until a sufficiently thick coating of the poison formed. The material is also used as a fish poison, the roots being crushed and placed in water inhabited by fish, and the fish upon dying float to the surface and are gathered up, and are quite harmless for food purposes. Chinese gardeners have apparently used the material for a long time as an insecticide, the fresh root being chopped and pounded in water and the milky fluid so obtained sprayed or brushed over the plants to be treated.

The poisonous principle of derris is associated with a resin, which has been variously named "derrin" and "derrid." The amount of derrin contained in the dried roots may vary apparently from practically none to approaching 20 per cent. The roots of the various species differ greatly in derrin content, so that it is apparent that only certain ones can be grown for insecticidal purposes, and indeed the cultivation of only certain definite species is being practised. However the derrin content of the root varies also with the method of cultivation, the soil, and the time of collection. From this it is apparent that purchases of the material will have to be made upon a basis of the derrin content.

The actual poison, which is associated with the above mentioned derrin, has been isolated and has been named "tubatoxin," which appears to be a rather inappropriate name. It is white, crystalline, insoluble in water, weak acids and alkalis, soluble in methyl, ethyl, and amyl alcohols, acetone, petroleum ether, glycerol, benzene, toluene, glacial acetic acid and olive oil. It has the empirical formula $C_{18} H_{18} O_5$ and melts at 163.5 degrees. It is to be noted that the substance is insoluble in water, for this has a marked bearing upon its insecticidal action. However, it is also to be noted that when the powdered root is mixed with water, a large part of the root including that containing the poison goes into a milky suspension, so that the poison while not soluble in the water is in an exceedingly finely divided suspension either colloidal or approaching

colloidal. Taken by way of the mouth derris is reputed to be non-poisonous to higher forms of life, and certainly to the writers' own knowledge appreciable quantities, probably about one gram, can be eaten with absolute impunity. Injected subcutaneously tubatoxin is reported to be absorbed slowly. Injected intravenously tubatoxin is an exceedingly powerful poison, the symptoms produced being apparently a general paralysis, and the lethal dose is apparently of about the same order as that of strychnine, namely, somewhat under one milligram per kilogram of body weight. The non-toxicity of derris to higher animals, when taken by way of the mouth, is of considerable importance and interest. Apparently, due to the fact that the poison is insoluble in water, weak acids or alkalis, the material must pass through the digestive system unchanged. It would appear that the poison had to reach the blood stream before being toxic to higher animals.

Observed Action on Insects

Used against insects, derris kills by some sort of paralysis. Insects can be observed with some legs functioning normally, but others totally paralysed; sometimes an insect will appear to be paralysed on one side and will gyrate in small circles. Caterpillars can be frequently noted with the caudal segments completely paralysed and the remainder normal. Later they become completely paralysed, and after becoming so, some insects have been observed to have some intermittent convulsive spasms before death. Occasionally some insects have been noted to recover from this paralysis, and to again appear normal, only later to be again seized and eventually to die. The action of derris is in many cases very rapid and paralysis may be noted in from ten to fifteen minutes after application, with death following very rapidly, but in other cases the action is very prolonged, with death taking place as long as ten or more days after application. On becoming partially paralysed, insects are unable to retain their hold on the plant or other surfaces and fall to the ground where they may remain alive for some time but very rarely seem to recover sufficiently to again crawl up the plant. Aphids are more liable to retain their hold on the plant and fall off at considerable periods later.

In the literature on the subject, derris is generally described as being both a stomach poison and a contact poison against insects. However, as far as our observations extend, we would be disposed to regard it as a contact poison only, though of course it will kill many groups of insects only generally handled by stomach poisons. While we are certainly not in a position to say that derris is not a stomach poison, yet we have seen no evidence that would lead us to believe that derris is any more digestible in the insects digestive juices than in those of higher animals. The idea that derris is a stomach poison seems to have arisen from the fact that some insects placed upon plants previously treated with derris and allowed to feed there, will die. However, we have noted that the same insects will die if placed upon a leaf or other surface previously treated with derris, and no feeding takes place at all. Speaking generally, it has been noted that:

1. There is a very much greater and more rapid mortality among insects where the insects themselves are treated with derris along with the foliage, than where foliage is treated with derris and the insects afterwards placed on the foliage.

2. Insects placed on treated foliage may die, but in such situations they tend to feed but very little, and have been noted to become paralysed

and die without feeding at all. Insects have been noted to die after being placed on other surfaces treated with derris, where there was no question of feeding.

3. Insects fed with a bait containing derris, where the insect comes but little in contact with the bait, are not seriously affected.

From the above we can only come to the conclusion that derris is mainly toxic by contact, and much less toxic as a stomach poison if indeed it is toxic in this latter connection at all. It would appear more reasonable to suppose that, as with the higher animals, derris is insoluble in the digestive juices and has to find entrance to the blood to be toxic. Entrance to the insect's blood would presumably be obtained through the spiracles.

Insecticidal Value of Derris

1. Against the Colorado Potato Beetle (*L. decemlineata Say.*)

On July 11th, 1925, sprays were applied to a block of potatoes at Annapolis Royal, heavily infested with potato beetle larvae which were on the average about half grown. A check was left and one plot sprayed with calcium arsenate at standard strength for comparison. Table I shows both the schedule of treatments and the results.

Table I. Experiment 4864

Plot	Insecticide in 4-4-40 Bordeaux	Per cent. Control			
		July 12	July 13	July 14	July 15
2	½ lb. derris	30%	70%	70%	70%
3	1 lb. "	90%	97%	97%	95%
4	2 lbs. "	100%	....	....	....
6	1 lb. calcium arsenate	No control	65%	75%	85%
Check	....	....	....	....	Plants devoured.

It will be seen from this table, derris even as low as one-half a pound per forty gallons gave considerable control and was more rapid in its action than the one pound of calcium arsenate. It should be mentioned that this is the result from only one application, and had the application been repeated, it looks as though derris as low as one-half a pound per forty gallons of Bordeaux might give a fair commercial control. At the strength of one pound of derris per forty gallons, 90 per cent. of the beetles ceased eating within a very short time, while with the calcium arsenate approximately half of them went on feeding for thirty-six hours. In severe epidemics the rapid action of derris would be a great factor in its favour.

In order to get more accurate data than could probably be obtained from field notes, the following feeding experiment was initiated in the insectary at Fredericton, N.B. Reference to the schedule of plots will show that there are two series of treatments, plots 1 to 6 consisting of 4–4–40 with gradually increasing strengths of derris, while plots 7 to 12 consisted of the corresponding strengths of derris added to a mixture of hydrated lime only in water. It was thus our purpose to get not only the absolute control obtained by derris at the various strengths, but also to get its comparative toxicity when used in the two different

mixtures, or to put it briefly, to see whether derris had its toxicity reduced or increased when used with Bordeaux. In going through the tables of results for this experiment it must be remembered that throughout the various series here the sprays were first applied to the foliage and allowed to dry before the larvae were placed thereon. This is a point, the importance of which will be understood better when the discussion of other experiments is reached.

Table II. Experiment 4812. Plot Sheet

In this table the derris-hydrated lime mixture is composed of equal parts derris and hydrated lime.

Plot 1—4-4-40 plus 1 lb. derris hydrated lime mixture
" 2—4-4-40 " 2 lbs. " " " "
" 3—4-4-40 " 3 " " " "
" 4—4-4-40 " 4 " " " "
" 5—4-4-40 " 5 " " " "
" 6—4-4-40 " 6 " " " "
" 7—1 lb. derris hydrated lime mixture to 40 gallons water
" 8—2 lbs. " " " " " 40 " "
" 9—3 " " " " " " 40 " "
" 10—4 " " " " " " 40 " "
" 11—5 " " " " " " 40 " "
" 12—6 " " " " " " 40 " "

Table III. Experiment No. 4812 (B)

Derris to control potato bug, alone and in combination sprays.

Experiment begun at 4 p.m., July 13th; concluded at 10 a.m., July 17th. Time 90 hours.

Tray No.	No. Larvae	10 a.m., July 14		10 a.m., July 15		10 a.m., July 16		10 a.m., July 17		Total Dead
		Off Plant	Dead	Off Plant	Dead	Off Plant	Dead	Off Plant	Dead	
1	25	18	3	16	5	14	6	11	11	25
2	25	17	10	10	3	9	8	4	3	24
3	25	23	8	15	2	14	14	1	1	25
4	25	22	16	7	2	5	5	2	1	24
5	25	25	25	......	......	......	......	......	......	25
6	25	25	25	......	......	......	......	......	......	25
7	25	25	25	......	......	......	......	......	......	25
8	25	25	25	......	......	......	......	......	......	25
9	25	25	25	......	......	......	......	......	......	25
10	25	25	25	......	......	......	......	......	......	25
11	25	25	25	......	......	......	......	......	......	25
12	25	25	25	......	......	......	......	......	......	25

On account of the high rate of mortality in Trays 5 to 12, the experiment was repeated, beginning the C series at 10 a.m., July 14.

Table IV. Experiment No. 4812 (C)

Derris to control potato bug, alone and in combination sprays. Eight fluid ounces of the material used in No. 4812 (B) diluted with an equal quantity of water to make up each spray.

Experiment begun 10 a.m., July 17th; concluded 10 a.m., July 17th. Time 72 hours.

Tray : No.	No. Larvae	10 a.m., July 15		July 16		July 17		July 18		Total Dead	Variation from (B)
		Off Plant	Dead	Off Plant	Dead	Off Plant	Dead	Off Plant	Dead		
1	25	16	2	18	3	20	20	....	....	25	0
2	25	22	2	21	0	23	23	....	....	25	—1
3	25	25	4	16	1	20	20	....	....	25	—1
4	25	25	2	19	19	....	....	....	....	21	—3
5	25	23	2	23	23	....	....	....	....	25	0
6	25	19	2	23	23	....	....	....	....	25	0
7	25	13	1	24	21	....	....	....	....	22	—3
8	25	23	3	23	23	....	....	....	....	25	0
9	25	23	1	24	24	....	....	....	....	25	0
10	25	21	3	22	22	....	....	....	....	25	0
11	25	25	5	20	20	....	....	....	....	25	0
12	25	25	5	20	20	....	....	....	....	25	0

A "D" series was started, using 4 fluid ounces of the solutions of 4812(B), plus 12 ounces of water.

Table V. Experiment No. 4812 (D)

Derris to control potato beetle larvae.

Experiment begun 3.30 p.m., July 16th; completed July 18th. Time 48 hours.

Tray No.	No. Larvae	July 17		July 18		Total
		Off Plant	Dead	Off Plant	Dead	
1	25	21	1	24	24	25
2	25	22	7	18	18	25
3	25	22	5	22	19	24
4	25	25	8	17	17	25
5	25	25	11	14	14	25
6	25	25	9	16	16	25
7	25	22	2	23	23	25
8	25	23	7	16	18	25
9	25	22	9	16	16	25
10	25	25	12	13	13	25
11	25	25	11	14	14	25
12	25	24	8	14	16	24

The trays treated with the materials comprising a small quantity of derris with Bordeaux mixture gave in both tests a slower action than in those where a larger amount was used.

The trays treated with the solution not containing Bordeaux gave a more rapid and complete kill. This is possibly due to repellant action of the Bordeaux mixture preventing the larvae from feeding freely on the foliage if derris is an internal poison.

Table III shows very graphically to what extent Bordeaux restricts the effectiveness of derris.

The series D, Table IV, is rather remarkable in showing that derris as low as one-sixth of a pound to forty gallons, plots 1 and 7, gave 100 per cent. mortality.

When this experiment was conducted on a larger scale in the field, derris one-half a pound to forty with both Bordeaux and hydrated lime gave 95 per cent. control. All strengths above one-half to forty gave complete control.

All the experiments discussed so far have been on the use of derris in spray form.

The following is a discussion of derris used as dust against Colorado potato beetle. A feeding experiment, No. 4811, was conducted in the insectary at Fredericton, N.B., in which derris was used in two different combinations; in one, mixed with hydrated lime alone, and in the other mixed with Bordeaux dust. In Table VI will be found the schedule of treatments:

TABLE VI. EXPERIMENT 4811. PLOT SHEET

Plot	1—2 lbs. derris plus 98 lbs. hydrated lime
"	2—3 " " " 97 " " "
"	3—4 " " " 96 " " "
"	4—5 " " " 95 " " "
"	5—6 " " " 94 " " "
"	6—12-2-86 Dust (dehyd. $CuSO_4$, derris, hyd. lime)
"	7—12-3-85 " " " " " "
"	8—12-4-84 " " " " " "
"	9—12-5-83 " " " " " "
"	10—12-6-82 " " " " " "
"	11—12-7-81 " " " " " "
"	12—12-8-80 " " " " " "
"	13—100% derris.

For results see Tables VII and VIII.

In this experiment fronds of potato foliage were dusted with the various materials, set in trays and the larvae placed on the foliage, the insects thus not getting a direct application of dust.

In the B series, the dead larvae remained in the trays until the 10th of July. The record of total dead is the number of dead taken out on the 10th plus the dead taken out on the 11th. Difficulty was found in determining just when a larva was dead and when shamming. In the C series, the dead were removed daily.

TABLE VII. EXPERIMENT No. 4811 (B)

Derris to control potato beetle.

Tray experiment begun 3 p.m., July 8th; concluded 10 a.m., July 11th. Time 67 hours.

Tray No.	No. Larvae	9 a.m., July 9		4 p.m., July 9		9 a.m., July 10		10 a.m., July 11		Total Dead
		Off Plant	Dead	Off Plant	Dead	Off Plant	Dead	Off Plant	Dead	
1	25	0	0	5	4	7	4	9	5	9
2	25	14	4	16	9	18	10	23	11	21
3	40	24	3	28	9	29	10	18	11	21
4	25	16	11	18	16	19	17	7	5	22
5	25	7	0	18	10	19	9	16	9	18
6	25	8	0	13	6	19	8	14	13	21
7	25	15	0	17	5	26	0	16	14	19
8	25	6	0	16	8	16	9	16	5	14
9	25	12	6	17	9	22	15	8	3	18
10	25	14	0	21	12	21	12	12	12	24
11	25	26	0	28	11	28	21	4	4	25
12	25	11	1	18	16	25	20	5	5	25
13	25	24	24	25	25	......	......	......	......	25*
14		Dead larvae removed July 10. A fresh stem put in Tray 13 and 25 fresh larvae put on it. No dust applied to leaves; some remaining on cotton beneath plant...						25	25	25

*Straight derris.

TABLE VIII. EXPERIMENT No. 4811 (C)

Derris to control potato beetle.

Experiment begun 10 a.m., July 13th; concluded July 17th. Time 96 hours.

Tray No.	No. Larvae	9 a.m., July 14		9 a.m., July 15		9 a.m., July 16		10 a.m., July 17		Total Dead	Variation (B)
		Off Plant	Dead	Off Plant	Dead	Off Plant	Dead	Off Plant	Dead		
1	25	4	1	6	6	8	1	5	1	9	0
2	25	13	1	13	6	15	7	9	0	14	—7
3	25	18	0	22	3	18	10	9	2	15	—6
4	25	19	5	18	4	12	8	7	4	21	—1
5	25	17	3	18	0	17	7	9	0	10	—5
6	25	8	2	13	2	12	2	12	2	8	—13
7	25	8	0	10	1	13	3	12	3	7	—12
8	25	13	6	12	1	12	4	8	1	12	—2
9	25	10	0	21	4	19	8	8	2	14	—4
10	25	20	0	19	5	17	3	14	3	11	—13
11	25	16	0	20	8	11	3	9	2	13	—12
12	25	22	11	14	2	13	9	3	0	22	—3
13	58	58*	58*	Tray was shaken until out all visible dust was gone. A branch bearing bugs was put in 10 a.m., July 14.; 17 off 10 a.m., July 15.							

*Straight derris, all dead.

The mortality generally increased with the increased amount of derris in the dust. The results are not at all uniform. Attention is directed to the results in plots 5, 6, and 7, which show slow action in the first twenty-four hours.

The C series ran for a greater number of hours than the B's but show a lower mortality rate in most instances. The B series had a number of first instar larvae used. For the C series, only second instar larvae were used and they were probably more resistant than the small individuals.

Summarizing briefly, it will be seen that although three per cent. derris was sufficient to give a commercial control in the first series, in the second series the results lacked uniformity and were not so satisfactory.

The dusts used in this feeding experiment were also used on a larger scale in the field. Our results there showed that, while three per cent. derris with 7 per cent. hydrated lime gave complete control of potato bugs, when added to Bordeaux dust, four per cent. of derris was necessary.

The above recorded experiments against the potato beetle represent only a small portion of the data we have available and were chosen as being fairly typical. In the insectary very small amounts of derris are highly toxic to potato beetles, in the field larger amounts appear to be necessary. The following points seem to be fairly well brought out:

1. Derris is effective in both spray and dust form.
2. Derris kills more rapidly than arsenicals.
3. Derris is apparently less effective mixed with hydrated lime, and still less effective mixed with Bordeaux.
4. To get the same eventual kill, one pound of derris is apparently about equivalent to from one and a half pounds to three pounds of calcium arsenate.

II. Against the Forest Tent Caterpillar (*Malacosoma disstria* Hbn.)

Three webs of forest tent caterpillar collected soon after hatching in spring were kept in trays in the insectary and fed foliage of choke-cherry. One tray had foliage dusted with straight derris, one tray had foliage dipped in a one per cent. suspension of derris in water, and in the third tray the foliage was not treated. Fresh lots of foliage were treated and added twice weekly. The foliage in all trays was eaten freely, no dead caterpillars were found, and all developed at the same rate to full size.

In this experiment a derris was used which was some five or six years old, and experiments on other insects showed that the material had a definite insecticidal value though much lower than that possessed by most of the derris used in the experiments described in this article. It must be noted that in this experiment the derris was applied to the foliage alone, and not to the caterpillars.

III. Against the Orchard Tent Caterpillar (*M. americana* Fab.)

Larvae of the tent caterpillar were placed on foliage which had been previously treated with varying amounts of derris.

Derris five pounds per 100 gallons of water:

Larvae nearly all stupified in one day and nearly all dead in three days.

Derris ten pounds per 100 gallons of water:

Larvae all completely paralysed in one day and all dead in three days.

In the above, as practically no feeding took place, the material must have killed by contact.

The above was repeated, only this time the insects were sprayed along with the foliage, with results, at these dilutions, about identical with the foregoing.

Foliage containing larvae of the tent caterpillar was dusted with hydrated lime, containing an admixture of derris varying from two per cent. to twenty per cent. This was done under dry conditions, there being no moisture on the leaves at any time.

8% derris gave 60% control in 7 days.
15% " " 40% " " 3 " and 100% control in 7 days.
20% " " 70% " " 3 " " " " 6 "

Subsequent experiments with other insects showed that the presence of moisture greatly aided the efficiency of derris, but the above indicates its efficiency under perfectly dry conditions against this insect.

In the following series derris is tested at weaker strengths and compared with standard materials. The materials are (a) applied to the foliage alone and (b) applied to the caterpillars as well as the foliage. Ten caterpillars in each tray, nearly full grown.

TABLE IX

Material	Applied to foliage alone	Applied to caterpillars and foliage
Lead arsenate, 2 lbs. per 100 gals.	All died on 4th day, none before	10% dead on 3rd day 60% " " 4th "
Lead arsenate, 3 lbs. per 100 gals.	90% died on 4th day, none before	20% dead on 2nd day 60% " " 3rd " 90% " " 4th "
Check	10% dead on 3rd day. Feeding vigorously	All living Feeding vigorously
Derris ½ lb. per 100 gals.	10% dead 1st day 20% " 2nd "	10% dead 2nd day
Derris 1 lb. per 100 gals.	10% dead 2nd day	100% dead 1st day
Derris 2 lbs. per 100 gals.	30% dead 1st day 50% " 2nd " 70% " 4th "	100% dead 1st day
Derris 5 lbs. per 100 gals.	50% dead 2nd day 80% " 3rd "	80% dead 1st day 90% " 2nd " 100% " 3rd "
Check	None dead	10% dead 2nd day
Nicotine sulphate, ¾ lb. per 100 gals	10% dead 4th day	10% dead 3rd day
Nicotine sulphate, 1½ lbs. per 100 gals	20% dead 4th day	20% dead 1st day

The above experiment is very illuminating: (1) The derris applied to the caterpillars along with the foliage gave very much higher control than where applied to the foliage alone; (2) one pound of derris per 100 gallons of water gave an equal eventual control, though much more rapidly, than two pounds of lead arsenate; (3) when applied direct to the foliage but not to the caterpillars derris was not quite equal pound for pound to lead arsenate; (4) derris was very much more effective than nicotine in practical strengths.

IV. AGAINST THE IMPORTED CURRANT WORM (*P. ribesii* Scop.)

The following table is self-explanatory. This relates to an experiment in the insectary in which derris is compared with lead arsenate.

Table X. Experiment No. 4805. Currant Worms on Foliage when Dipped

Plot	Material per 100 gals. water	3 hours after application	24 hours after application	48 hours after application
1	Lead arsenate, 2 lbs.....	....	80% dead	95% dead
2	Lead arsenate, 5 lbs.....	....	100% "	....
3	Check..................	....	....	All alive
4	Derris, ½ lb...........	100% dead	....	....
5	" 1 lb............	100% "	....	....
6	" 2 lbs...........	100% "	....	....

From the above table it is evident that derris is extraordinarily effective against this insect. Lead arsenate applications required from one to two days to kill but even one-half pound of derris per 100 gallons killed all insects within three hours.

In the following experiment a large currant plantation was available heavily infested with this insect. Derris was used as a spray in six different strengths, as follows: derris ten pounds per 100 gallons; five pounds, 2.5 pounds, 1.25 pounds, 0.63 pounds, and 0.31 pounds, per 100 gallons. This experiment was done in duplicate, abundant checks being left.

On all these plots there was 100 per cent. control of these insects after two days, the higher strengths paralysing the larvae almost immediately but the weaker strengths taking a longer time. It is to be noted that one-third pound of derris per 100 gallons gave complete control.

A series of dust plots was also applied in a heavily infested currant plantation, the experiment being done in duplicate leaving abundant checks, and comparing with nicotine dusts. Four plots containing derris were used, the filler being hydrated lime, as follows: derris 10 per cent., 5 per cent., 2.5 per cent., and 1.25 per cent. Nicotine dusts were also used of two per cent. and one per cent. actual nicotine content.

All the derris plots gave 100 per cent. control of this insect. With regard to the nicotine plots, many of the insects were brought down and killed at the time of application, but a considerable number remained on the plant, and three days later these were feeding vigourously. The stronger strength of nicotine dust gave about an eighty per cent. control, and the weaker strength less than this. It is to be noted that a dust containing 1.25 per cent. derris was more effective than a two per cent. nicotine dust against this insect.

V. Against the House Fly (*Musca domestica.*)

Derris at the rate of five pounds per 100 gallons was sprayed on house-flies. The spray was shot at them both while they were resting and while they were on the wing. Such flies became restless almost immediately and commenced cleaning themselves vigourously. Most flies so treated were dead within twenty-four hours, and as far as could be ascertained all were dead within forty-eight hours.

Derris was also dusted on house-flies but in this case the action was much slower and after one day none were dead, and it was thought the material was not effective. These flies were not kept under observation afterwards but later work with derris led us to think that had they been kept under observation longer, a subsequent mortality might have been noted.

Derris spray was also observed to kill several other flies of undetermined species, and was also observed to kill certain noctuid moths.

VI. Against the Carrot Rust Fly (*Psila rosae* Fab.)

Derris, in either dust or liquid form, gave a considerable measure of control against the carrot rust fly, the material being applied to the soil surface about the time egg-laying was in progress, the control being apparently also accompanied by a plant stimulation. A considerable amount of work has been done on this project and at a later date a special paper will be prepared by one of us dealing with the control of carrot rust fly by derris.

VII. Against Clothes Moths.

A trunk of woolen goods swarming with adult clothes moths was given a liberal application of a 50-50 derris-hydrated lime mixture. Four days later all moths were dead. The trunk was examined a month later and no living larvae and no moths were found.

VIII. Against Bed Bugs (*Cimex lectularius L.*).

A number of bedbugs were confined in a vial with derris dust. They were active for two hours, but were all dead after three and one-half hours.

IX. Against Budmoths (mostly *Spilonota ocellana* Schiff.).

Derris at the rate of two pounds per 100 gallons was applied to a considerable area of apple trees at varying periods in the latter part of July and early August, just about the hatching period of the budmoth. Plots using four pounds of lead arsenate per 100 gallons, and others using one pound nicotine sulphate, were also used. In conjunction with all, one pound of calcium caseinate per 100 gallons was used.

On both the lead arsenate and the nicotine sulphate plots there was a measure of control of the budmoths, varying from 50 per cent. to 75 per cent., but on the derris plots there was only a very slight control of less than 10 per cent. Derris used in this manner is apparently ineffective against budmoths.

X. Against the Fall Web Worm (*Hyphantria cunea* Drury).

Derris was used as a spray against the fall webworm in various strengths up to ten pounds per 100 gallons. Not even at the stronger strengths did the derris have the slightest effect, whereas lead arsenate sprays killed them readily. Derris dusts were ineffective also. It is evident that the fall webworm is quite strongly resistant to the poisonous effects of derris.

XI. Against Green Apple Aphis (*A. pomi* De G.).

While our preliminary experiments with derris against sucking insects in 1924 had not been very conclusive, we nevertheless decided to make further trials. In 1924 we did not always have a freshly ground and mixed dust, both of which conditions may be of importance, also as the results from nicotine, the material used as our standard of comparison are usually obtained within twenty-four hours; we had usually concluded our observations in less time than we have since found it necessary to derive full benefit from derris.

Reference to Table XI will show both the schedule of treatments and results of experiment 4868 conducted against the green-apple aphis, a species which is notoriously resistant to contact insecticides. As will be seen, the derris and nicotine sulphate 40 per cent. appear in two series, each being used without soap and again with soap. Derris, five pounds in 100 gallons without soap, plot 5, gave practically complete control, being a little superior to one pound of nicotine sulphate 40 per cent. With the addition of a little soap to the solution, derris as low as 2½ pounds to 100 gallons water gave 100 per cent. mortality, and is superior to one pound nicotine sulphate 40 per cent. See plots 4 and 8.

In experiment 4856, derris was tried in dust form against a severe outbreak of this pest in a nursery near Annapolis Royal, N.S., but it was found that derris as high as 10 per cent. with hydrated lime failed to give anywhere as near satisfactory results as a 5 per cent. nicotine sulphate 40 per cent. dust. A later experiment, No. 4865, showed that derris requires moisture to make its toxic properties effective and it is just possible that we may yet find a use for derris dust as a contact insecticide if applied when the foliage is wet. In an insectary experiment, No. 4800, derris as high as 20 per cent. with hydrated lime proved ineffective against the green-apple aphis when applied to dry foliage. Unfortunately we did not have an opportunity to try it on wet foliage against this species.

Table XI.

Plot	Material	No. dead fallen from leaves			No. dead and alive on leaves 3 days after applying		Total		
		3 hrs.	18 hrs.	64 hrs.	Dead	Live	Dead	Live	% Killed
1	¼ lb. derris, 40 gals. water	36	123	324	576	549	900	549	62.0
2	¼ lb. derris, 40 gals. water with soap	20	29	30	1,072	58	1,102	58	95.0
3	1 lb. derris, 40 gals. water	28	66	88	1,010	227	1,098	227	82.8
4	1 lb. derris, 40 gals. water with soap	3	6	8	1,009	0	1,017	0	100.0
5	2 lbs. derris, 40 gals. water	53	115	173	1,893	12	2,066	12	99.4
6	2 lbs. derris, 40 gals. water with soap	25	30	37	1,675	1	1,712	1	99.9
7	1:800 sol. Nicotine sulphate 40%	103	194	196	1,152	83	1,348	83	94.2
8	1:800 sol. Nicotine sulphate 40% with soap	3	5	13	972	55	985	55	95.7
	Check	0	1	6	54	263	60	263	18.5

XII. Potato Aphis (*M. solanifolii* Achm.).

In view of the unsatisfactory results from derris dust applied dry to the green-apple aphis, it was fortunate that later in the season an outbreak of potato aphis gave us a chance to test out the material again thoroughly, using wet and dry foliage, the same occasion also being used for another trial of derris in liquid form as a contact insecticide. On referring to Table XII, the treatments and results will be found.

Table XII. Experiment 4865. Derris Against Potato Aphis, September 2.

Plot	Materials	Sept. 3rd	Sept. 5th	Sept. 7th
1	Derris 10 lbs., water 100 gals...	70% dropped	90% control	100% control
2	" 5 " " " "	80% "	95% "	100% "
3	" 2.5 " " " "	50% "	60% "	60% "
4	" 10 " Hyd. lime 90 lbs.	20% "	60% "	90% "
4a	" 10 " " " " wet	55% "	99% "	100% "
5	" 5 " " " 95 lbs.	2% "	10% "	Foliage shrivelled
5a	" 5 " " " " wet	55% "	100% "	100% control
6	" 2.5 " " " 97.5 "	1% "	5% "	All dead, but foliage shrivelled
6a	" 2.5 " " " " wet	30% "	95% "	100% control
7	Check......................	None	No drop "	Still feeding
8	Nicotine sulphate 40%, 1 pt. water 100 gals.............	80% "	100% control	100% control
9	Nicotine sulphate 40%, ½ pt. water 100 gals.............	80% "	90% "	100% "
10	Nicotine sulphate 40%, ¼ pt. water 100 gals.............	25% "	50% "	Foliage shrivelled One or two alive

In this experiment, to keep them fresh, the fronds of potato foliage thickly infested with aphids were placed, after treatment, in angle-neck bottles of water. White sheets of paper were set beneath the foliage so that one could see at once as soon as the aphids commenced dropping. In the case of the dust, one series simply had the dust blown on dry, while with the other series the foliage was dipped in water first and the dust then blown on. Comparing plots 4, 5, and 6 with 4a, 5a, and 6a, it will be seen that the presence of moisture had a marked effect in increasing the toxicity of derris, for derris as low as 2.5 per cent. derris in dust gave complete control. This, of course, was in the insectary and whether we would have similar results under field conditions with this species remains to be proven. In plot 2, it will be seen that derris in spray form required 5 pounds per 100 gallons water to produce 100 per cent. mortality, while nicotine sulphate 40 per cent., one-half a pint to 100 gallons gave the same control. In all cases it was found that derris was much slower in action than the nicotine.

XIII. Against *Aphis rumicis L.*

In an insectary experiment, No. 4798, against *Aphis rumicis*, 5 pounds of derris in 100 gallons of water had been put down as giving only 40 per cent. control, and thus compared very unfavourably with the result from nicotine sulphate 30 per cent. used at the strength of one-half a pint to 100 gallons, which gave 90 per cent. control. The experiment was regarded as concluded, but on

going to the insectary two days later, it was found that all the aphids were dead on the derris plot. This slowness of action by derris has been noted by other observers. The aphids are apparently partially paralysed and may remain on the foliage motionless and apparently healthy for days before they finally wither up.

XIV. Against Imported Cabbage Worm (*P. rapae L.*)

Growers of cabbage are usually very reluctant to apply arsenicals to this vegetable. As derris is stated to be innocuous to higher animals, we conducted several experiments with this material against the cabbage worm both in 1924 and 1925. In 1924 the plants were rather far advanced, heads having been formed sometime, and many of the caterpillars were almost fully grown. Dusts were blown on with a small hand duster.

Table XIII, which follows, shows treatments and results.

Table XIII.

Plot	Derris in Hyd. lime	A. No. alive per head
1	1%	0.6
2	2%	0.3
3	5%	0.2
4	10%	0.3
Check	(40 plants had 171	larvae alive) 4.3

The moisture usually retained by cabbage foliage undoubtedly assisted in bringing out the toxic properties of derris.

In 1925, further trials of this material were made. In experiment 4863, derris was used as a spray, two small plots of lead arsenate also being included for comparison. Sunoco oil was added to aid spreading. The treatments and results were as follows:

Table XIV.

Plot	Material per 100 gals. water plus 3 pints Sunoco	Per cent. Cabbage infested	Larvae per plant
1	Derris 5 lbs.	0	0
2	" 2½ "	30	0.3
3	" 1¼ "	27	0.66
4	" 0.62 "	10	0.1
5	Lead arsenate 5 lbs.	44	0.55
6	" " 2.5 "	80	1.3
	Check	100	4.5

The plants had been headed out some time and as these larvae continue to eat towards the heart of the plant, the main difficulty encountered in the control of this pest is the mechanical one of getting the treatment to reach them. Sprayed at an earlier stage of growth we are confident that weaker solutions than 5 pounds derris to 100 gallons water would have given even better control than was the case here.

In experiment 4861, treatments with derris in both spray and dust form were repeated, for results of which see Table XV.

TABLE XV. ABOUT 25FT. OF ROW IN EACH PLOT. RESULTS 24 HOURS AFTER APPLYING, AUGUST 21ST, 1925.

Plot	Materials	No. alive	No. dead	% killed	Remarks
1	Derris 5% Hydrated lime 95%	63	65	50.8	None of dead were over ½ inch long. No large ones killed. Had results been taken at a later date probably more would be dead.
2	Derris 2.5% Hyd. lime 97.5%	78	35	30.9	" " " "
3	Derris 1.25% Hyd. lime 98.75%	103	12	10.4	" " " "
4	Derris 5 lbs. Sunoco 3 pints Water 100 gals.	3	76	96.2	
5	Derris 2.5 lbs. Sunoco 3 pints Water 100 gallons	6	62	91.2	
6	Derris 1.25 lbs. Sunoco 3 pints Water 100 gals.	17	58	77.3	
7	Derris 0.62 lbs. Sunoco 3 pints Water 100 gals.	37	49	56.9	
8	Check	123	0	0	

As will be seen from this table, derris is more effective used in liquid than as a dust for as low as 2½ pounds in 100 gallons gave a mortality of over 90 per cent. These materials were applied August 21st and much better results would doubtless have been obtained had applications been made earlier, for then the plants would have been more open and the caterpillars younger.

XV. AGAINST MISCELLANEOUS INSECTS AND ANIMALS.

Undiluted derris dust, applied with a hand-duster, gave 100 per cent. control of larch sawfly larvae.

Derris dust had apparently no effect on Chermes.

The three-lined potato beetle was controlled by a dust application of 50-50 derris and hydrated lime.

The same mixture as above had apparently no effect on the squash bug.

A red aphis on goldenrod and the currant aphis were not controlled on being dusted by the same mixture, but reasoning from other experiments it is possible they might have been if in the presence of moisture.

Derris, both dust and spray, gave a measure of control against the larch case bearer.

Derris, both dust and spray, was ineffective against the chain dotted geometer, but arsenicals were practically ineffective against them also.

Derris, 1½ pounds per 100 gallons water, with the addition of soap, was used against aphids on a cut-leaf birch. Geometrid larvae, ladybird beetle larvae and syrphid fly larvae were killed and dropped in a few hours, but the aphids did not appear to be affected during the first twelve hours. Two days later the tree was found to be completely free of aphids.

Derris was not effective in a bait fed to cutworms, either in the insectary or in the field.

It was noted in some cases that where dusts containing derris had been supplied to plants, and later rains had washed the dust into the soil, that the earthworms came to the surface of the soil and died.

Derris, applied at approximately the rate of one pound per 100 gallons, added to a large tank of water very heavily infested with mosquito larvae, completely killed all the larvae in three or four days.

It was also noted that if slugs travelled over a surface on which derris had been lightly sprinkled, that the slugs immediately became distressed and died in a few hours.

Derris, used undiluted and also one part derris to three parts dry cement powder, was found very effective against lice on cattle and horses.

Besides all the above insects utilized by us, it is well known that derris has been very successfully used as the insecticidal ingredient of certain proprietary sheep dips.

General Conclusions

During the next few years derris will probably be available in quantity, and at prices competitive with other insecticides.

Derris is a very effective insecticide over a wide group of insects, but by no means effective against all insects.

Derris kills very largely by contact with the external surface of the insect.

Where used against insects on plants, derris is effective both as a spray and as a dust, but is generally more effective as a spray, and when used as a dust is generally more effective under moist conditions.

Derris has physical properties which make it good for dusting purposes; for spray purposes it is advisable to make into a paste with a small quantity of water preparatory to diluting.

Used on a number of varieties of plants, and used at much greater strength than is necessary, no foliage injuries on any plant were observed following its use.

Due to the material being practically non-poisonous to man, it should be especially useful where it is desired to make an application to food products, such as cabbages, currants, etc., within a short time of use.

MISCELLANEOUS NOTES ON LUBRICATING OIL SPRAYS WITH SPECIAL REFERENCE TO THEIR USE FOR PEAR PSYLLA CONTROL

William A. Ross, Dominion Entomological Laboratory, Vineland Station, Ontario

Petroleum products have been utilized as contact insecticides in North America for approximately fifty years. Kerosene emulsions came into use first, and about 1904 were followed by proprietary miscible oils. The history of home-made lubricating oil sprays apparently began about 1906, when Yothers, of the United States Department of Agriculture, used cheap lubricating oils with a paraffin base for the control of various citrus insects in Florida. It would appear, however, that Yother's work attracted comparatively little attention in the entomological world, and that its importance was not appreciated by economic entomologists until 1922-23, when Ackerman's results on the control of San Jose scale with lubricating oil emulsions were made known. During the

past three or four years, as most of you are aware, many entomologists and chemists have taken up and have made considerable progress in the study of lubricating oil emulsions, and from this work we are gradually accumulating more definite information regarding the extent of the field in orchard and garden entomology for cheap lubricating oil sprays; regarding methods of emulsification; regarding the emulsifiability of different petroleum products; regarding the chemical and physical properties of oils for various purposes, etc., etc.

In the fall of 1923, we initiated an investigation on lubricating oil sprays, primarily with the object of securing a cheaper and more effective contact spray than nicotine sulphate for pear psylla control. We had planned to test several kinds and grades of oils, but, on account of the pressure of other duties, we were forced to restrict our investigatory work to one lubricating oil—an oil sold by the Canadian Oil Company under the trade name of "Sterling Red Paraffin Oil." This oil has the following characteristics:

Gravity at 60 degrees F.	25.2 A.P.I.
Flash point (open cup)	360 degrees F.
Viscosity at 100 degrees F.	170 seconds (Saybolt)
Volatility (loss at 105 degrees—110 degrees C. after 4 hours)	.41%
Pour and solid	40 degrees, 35 degrees F.

Emulsifiers

Various emulsifiers—among others, soaps, copper sulphate and lime, calcium caseinate, sweet milk, sour milk, albumen, egg and glue—different formulae and different methods of emulsification were tested in the laboratory, and the more promising ones in the orchard. On the basis of this work we have decided, at least temporarily, to drop soap emulsions, because they entail too much labour and trouble; because they require a boiling outfit; because they are liable to break down in hard water;* and because in our orchard experiments they have shown no evidence of being superior to cold mixtures. Copper sulphate and lime, calcium caseinate, milk and albumen emulsions are easily prepared and mix readily in hard water, making a smooth and uniform spray mixture, but, judging by our experience this past season, it would appear that the Bordeaux oil will prove to be the most popular oil spray with growers, because copper sulphate and lime are always readily available.

In the orchard experiments the four cold emulsions were prepared according to the following formulae:

(1)	Sterling red paraffin oil	3 gallons
	Water	1½ gallons
	Copper sulphate	6 ounces
	Hydrated lime	6 ounces
(2)	Sterling red paraffin oil	3 gallons
	Water	1½ gallons
	Calcium caseinate	6 ounces
(3)	Sterling red paraffin oil	3 gallons
	Sweet skim milk	2½ pints
	Water	1½ gallons
(4)	Sterling red paraffin oil	3 gallons
	Water	1½ gallons
	Albumen	6 ounces

*This difficulty can be readily overcome by diluting the emulsion in a weak Bordeaux mixture.

Method of Emulsifying

In our experience the simplest method of making cold emulsions under orchard conditions is as follows:

Place a container with the oil in it alongside the spray outfit. Dissolve or mix the emulsifier in the water and pour this into the oil and stir. Take the suction hose out of the tank and put it into the oil mixture, start the engine, and under high pressure, pump the mixture back into itself through the gun until all the oil is properly emulsified. While this is being done, the tank should be filled with water. When the tank is full, and all the oil emulsified, the emulsion should be pumped into the tank through the gun.

In the case of a spray machine with no suction hose, sufficient material for one day's spraying should be emulsified in the tank, and the correct amount of emulsion for a tank of spray should be run off into each of several containers.

In connection with the manufacture and use of home-made lubricating oil emulsions, the following points are important:

(1) In making oil sprays, pumping under high pressure should be continued until the whole mixture has been converted into a thick, uniform emulsion *with no free oil in it.* A properly made emulsion will mix readily with water, giving a smooth, uniform spray material with *no oil floating on the surface.*

(2) In view of the fact that cold mixtures, such as Bordeaux and calcium caseinate emulsions, are not particularly stable, it is considered advisable to prepare them as needed at the time of spraying.

(3) If a stock emulsion is made some time prior to spraying and oil separates out of it, the mixture should be re-emulsified by pumping. If, however, the emulsion does not break down until diluted, the spray mixture should be emptied out on the ground—the oil scum must not be allowed to go on the trees.

(4) A three-per-cent. oil spray should be used for dormant or delayed dormant applications. It should never be applied to foliage.

(5) Oil sprays should not be applied until all danger of zero weather is past.

Pear Psylla Control Experiments

At the last annual meeting of the Entomological Society of Ontario, we presented a report on the 1924 experiments on pear psylla control, so that it will not be necessary to say anything further about them, except that they indicated a three-per-cent. oil spray would give clear-cut results in controlling the psylla. In 1924 we confined our work to one large pear orchard, but this season we carried on experiments in some twenty-two orchards, scattered through the main pear-growing district from Burlington to the Niagara river, and all very subject to psylla injury. In one orchard comparative tests with three-per-cent. Bordeaux, calcium caseinate, milk, albumen and soap emulsions were conducted; in another three- and four-per-cent. Bordeaux oil sprays were compared; in seven orchards three-per-cent. calcium caseinate oil was used; and in all the others the trees were sprayed with three-per-cent. Bordeaux oil. We had planned to do all the spraying after the "flies" emerged, and just before they commenced egg-laying, but, as a matter of fact, some eggs were deposited before spraying was completed; fortunately, however, this did not affect the results. In the two orchards where the comparative tests were run, all the emulsions gave equally good results, and the four-per-cent. oil spray gave no evidence of being superior to the three-per-cent. Furthermore, in all the experimental orchards, with the exception of

two,* one application gave excellent commercial control of the psylla. Up to the middle of September, when our last observations were made, the insect was scarce in oil-sprayed orchards; there was no serious leaf spotting; no defoliation and no smutting of the fruit. The results, to put it mildly, were remarkable. On the other hand, in the orchards which we used as checks and which had received: (1) a pre-blossom spray of lime sulphur and a post-blossom application of nicotine sulphate, or (2) at least a post-blossom spray of nicotine, the psylla was very abundant and injurious. In such orchards, generally speaking, the insect was abundant by mid-July; serious injury was conspicuous in early August; by the end of the month considerable defoliation had taken place, and the trees and fruit were smutty.

How are we to account for the remarkable results secured from one application of oil? Wetting the adults with the spray material at the time of spraying destroys a very high percentage of them, but, in some of our experimental orchards, we question if this by itself would have reduced the insect to insignificance, because in some instances living adults, while not at all abundant, were too easily found after spraying. We are of the opinion that the oil continues to function as an insecticide for some time after it is applied. Orchard observations indicate that the oil may act as a deterrent to some extent. It also seems possible that, when the trees are wet, some of the adults are killed by the oily film on the wood, and that many newly-hatched nymphs are destroyed by the oil film. We hope to secure definite information on these various points, and also on the value of the oil as an ovicide, from laboratory experiments which will be conducted at Vineland Station this winter.

We are not prepared to say that one application of three-per-cent. lubricating oil spray will by itself control the pear psylla every year. It is highly probable that, in some seasons and in some orchards, it will be necessary to supplement the oil spray with a later application of nicotine. The most we claim for the oil treatment at the present time is that it is much more effective and much cheaper than any control measures we have tried heretofore. The cost of the oil spray is approximately one-fourth that of lime sulphur and nicotine sulphate.

Other Uses for Oil Sprays

There is apparently quite a large field for lubricating-oil sprays. They have been used successfully against various citrus insects, San Jose, Putnam, fruit lecanium, cottony maple and European elm scales, pear psylla, fruit-tree leaf-roller, red-banded leaf-roller, redbug, various greenhouse scales and the onion maggot, and the present indications are that further experimental work will demonstrate that they are effective against such pests as orchard aphids, oyster-shell scale and the European red mite.

We have found that a three-per-cent. lubricating oil spray is apparently just as effective in controlling the black cherry aphis as lime sulphur and nicotine. We are carrying on oil-spraying experiments for the control of apple aphids, and the European red-mite, but so far no definite information has been secured from this work on account of the scarcity of the pests in the check plots.

*In these two orchards other fruit trees, interplanted with the pears, were not sprayed and the adult psyllas, present on these unsprayed trees, were responsible no doubt for the unsatisfactory results. According to our observations, adults migrated from other fruit trees to pears for at least two weeks after the oil spray was applied. In view of this it appears to be necessary to spray other fruit trees, interplanted with or immediately adjoining the pears, in order to secure clear-cut results.

Effect on Trees.—In view of the fact that kerosene emulsions, used year after year, have injured and killed trees, there is always the possibility that annual applications of lubricating oil sprays in fruit orchards may in time result in serious cumulative injury to the trees. Further work and time alone will tell if the use of oil sprays is attended by any such danger. All we know at present is that, so far, no authentic cases of injury to deciduous trees have been reported where two- to four-per-cent. oil sprays were properly used as a dormant or delayed dormant spray. We have used a three-per-cent. oil spray on apple (dormant and delayed dormant), sweet cherry (delayed dormant), pear (dormant), and peach (dormant), without impairing the vigour and health of the trees in any way. In one pear orchard, which was sprayed during the past two years with a three-per-cent. oil spray, the trees were never more thrifty in appearance than they were this season. We have seen no evidence so far that two- and three-per-cent. oil sprays retard bud development of healthy trees, although we have seen indications that such sprays may retard development on pear wood seriously weakened by the pear psylla, by low temperatures, or by both factors.

THE DISTRIBUTION OF INSECTS AND THE SIGNIFICANCE OF EXTRALIMITAL DATA

E. P. Felt, State Entomologist, Albany, N.Y.

The problems of distribution in relation to all animals, including extinct forms, are of great interest to biologists, and there is probably no group where these are more complex and where greater care is needed in interpretation than among the insects.

The distribution of the species is ordinarily interpreted as meaning the region or areas where the insect occurs. It is generally recognized that individuals are occasionally found some distance beyond what may be construed as the normal limits. The cotton moth, *Alabama argillacea* Hubn., is recorded by Dyar as occurring in the south Atlantic states. This record is accurate and yet millions of the moths appear every few years at least in parts of the northern United States and southern Canada. We may, if we wish, take the case of the monarch butterfly, *Danaus archippus* Fabr., a species recorded by Dyar as from the United States, and yet this insect is unable to hibernate successfully north of subtropical areas. It is true, however, that it breeds during the warmer portion of the season not only in the northern United States but presumably in southern Canada and possibly farther north than many realize. These two species are mentioned specifically simply to illustrate the difficulties in arriving at satisfactory criteria for the determination of distribution. Presumably most of us would admit that the distribution of an insect should include the entire area where it is able to breed, even if climatic extremes make hibernation impossible. Is it feasible to go farther and include in the area of distribution sections where adults, for example, appear rather commonly as in the case of the cotton moth? If we do this, shall we go farther and include in the distributional area localities where a few individuals have been found from time to time, although evidence indicates that the insects are probably far from their normal habitat and may be regarded as infrequent strays, rather than as permanent members of the local fauna?

A number of state lists have appeared, notably those of New Jersey, Connecticut and the list of diptera of New England. All of these are valuable additions to our knowledge concerning the range of different species of insects, and others will be published. The New York State list is practically completed and may be available in the not distant future.

The questions raised in a preceding paragraph are designed to provoke discussion in the hopes that we may arrive at a more definite idea as to the content of the word "distribution," as generally used by entomologists, and, furthermore, to suggest that in future lists it may be advisable to distinguish so far as may be possible the limitations of distributional data, in an effort to differentiate between areas where species are able to maintain themselves indefinitely, sections where seasonal breeding only is possible, and finally the regions which are subject to more or less regular invasion, usually by adults, without there being a reasonable possibility of reproduction.

The foregoing leads naturally to the consideration of the significance of what may be called extra-limital data, that is, records of insects occurring more or less commonly in regions where hibernation is impossible and also in sections where even breeding is prevented by various causes. These differences in the type of "distribution" are somewhat peculiar to insects, though they may be shared to a certain extent by winged vertebrates, particularly the birds, and to a more limited extent by some other animals. It is obvious that from an economic standpoint these distinctions are of considerable importance and one can hardly say less for the student interested in general biology and the distribution of life. The difficulty is to differentiate between these various types of distribution because our knowledge in regard to many species of insects is very limited. However, we possess a certain amount of information along these lines and it is only by collating this and calling attention to the possibilities in this direction that we can hope to make substantial progress along these lines in the future.

It is obvious that in the case of a butterfly, such as the monarch, unable to winter north of subtropical areas, that the annual occurrence of this insect over extended regions outside of the permanent habitat means an annual northward movement with the appearance of warm weather. There is no denying this movement. There may be some question as to whether it is a determinate migration or simply a more or less mechanical response or yielding to environmental conditions. It should be stated in this connection that somewhat similar movements are true of certain other butterflies and some other insects. There are those who claim that there must be a corresponding southerly movement on the part of species unable to withstand the rigours of a northern winter and, in the case of the monarch, the large swarms of butterflies rather frequently seen moving southward in the fall is believed by a number to be somewhat conclusive evidence of a return movement. This may be the case, though there is also the possibility that these swarms are simply a reaction to a hibernating instinct, as evidenced by the persistence of such assemblages through the winter in southern California.

It may be noted in passing that Mr. C. B. Williams believes that all Europe north of a line through the middle of France and south Germany or Switzerland depends entirely for its painted lady butterflies, *Pyrameis cardui* Linn., upon African areas south of the Great Desert, and in the case of this species there is very little evidence to suggest a return movement with the coming of cool weather.

The somewhat common movement of insects well beyond the limits of the possible breeding area, as in the case of the cotton moth, raises a question as to whether this may be a determinate migration or simply the yielding to favourable environmental conditions. With this latter species there is practically no question but that millions of moths seen somewhat commonly in northern cities and villages perish, and if this be the case with this species, what substantial grounds have we for assuming that the autumn swarms of the monarch butterfly, for example, do not meet a similar fate, and, as pointed out above, there is little probability of the painted lady butterflies making their way south from higher latitudes.

There are a number of other records along this line, notably the taking of the Mexican dexid, *Cholomyia inaequipes* Bigot in the Pacific states and *Tabanus septentrionalis* Loew, in New York and New England. A number of distinctly southern Coleoptera, such as *Enochrus consors* Lec., *Oxyporus bicolor* Fauv., *Boletobius dimidiatus* Er., *Eros sculptilis* Say, and *Longitarsus turbatus* Horn., have been taken upon Mount Washington, none with a recorded habitat north of New Jersey. The western *Thamnotettix pallidulus* Osb. has been captured at Presque Isle, Pa., as well as the typical southern *Dorydiella floridana* Baker, the latter a species apparently able to maintain itself in this northern habitat.

It is logical to assume that if southern insects are dropped on mountain tops far beyond their normal range that by no means all those drifting in the air would be taken at such places. In other words, these mountain-top collections are suggestive of hosts of individuals passing to the north and ordinarily escaping observation. The distance of the drift would depend largely upon favourable climatic conditions, namely, moderate temperatures and winds of sufficient strength to support the insects in large measure. A record of just such a drift has been published recently by C. S. Elton.* He records the finding by several parties in August, 1924, on the snow of North-East Land, Spitzbergen Islands, latitude 80° north, of a large black aphid identified as *Dilachnus piceae* Panx., and a flower fly, *Syrphus ribesii* Linn., in such numbers as to suggest that "hundreds of thousands or even millions" of these insects had been blown in a broad belt over the island. The fact that there are no trees proves that these insects must have come from some other country and it is surmised that they may have come from the Kola Peninsula, a distance of over 800 miles in a straight line. This idea, the author states, was confirmed by the fact that weather conditions during this period, August 6, 7 and 8, were favourable for strong south and southeast winds blowing from Europe over Spitzbergen and more especially North-East Land. It is suggested that these climatic conditions coincided with an extraordinary aphid infestation far to the south. This record, surprising though it may be, is what might be expected under favourable conditions if there is at times a somewhat general northward drift of insects. The extreme north is not a favorite collecting ground for entomologists and the scarcity of records is not surprising.

The above data taken by themselves may not be considered particularly conclusive and it therefore seems advisable to refer briefly to the numerous records of insects, sometimes in considerable swarms, being found at sea, miles from the nearest land and in certain cases at least under conditions which can suggest only the casual drifting with favourable winds. It is true that most of these records relate to large and somewhat strong-flying species. The reason

*Ent. Soc. Lond. Trans., p. 289–299, 1925.

why most of the records relate to large species is obvious, since they are the ones which most frequently attract the notice of casual observers. It is also evident that strong-flying forms would presumably be able to remain upon the wing for longer periods than weaker species. It does not follow from the latter, however, that the long distances covered are due primarily to the efforts of the insects. In fact it seems more reasonable to believe that wind currents have been important factors in this movement and this view is supported by the finding in different parts of the world of small, weak insects many miles from land, as in the case of several lighthouses or lightships, and as further evidenced by the insect drift along the shores of large bodies of water. Surely no one would hold that small midges, lace-winged flies and plume moths were able to cover many miles on the wing largely through their own efforts, though these species, as well as a number of larger, somewhat strong-flying insects, are admirably adapted to drifting for hours and possibly even for days with favourable winds. It therefore appears more reasonable to believe that many of these extensive movements of insects are due to a drifting with favourable winds and if this be accepted it is somewhat easy to explain not only the extralimital records mentioned above but also the appearance of numbers of insects miles from land, the millions sometimes occurring at lights in cities remote from breeding places, the extensive beach drift which occasionally comes to the attention of a naturalist, and the large accumulations of various species upon glaciers.

This is certainly the work of storms, some would say, and yet many of these insects have been observed under what we would consider normal conditions. High winds or violent storms as we call them at the surface of the earth are comparatively rare and, in our opinion, of minor importance in the dissemination of insects, compared with the gentle convection currents which carry insects to the somewhat rapid winds at a moderate elevation above the surface of the earth.

It is evident that the few specimens of the typical western or southern species taken in localities widely distant from their normal habitat must be only a small proportion of those which make their way into these outlying areas. In other words, these are fragmentary data indicating a movement which has been recognized only in the case of a very few conspicuous or somewhat common species. These data are very suggestive and, properly interpreted, may give valuable information in relation to the prevailing winds and the probable direction of wind drift. Furthermore, in the case of these scattering occurrences the probabilities are overwhelmingly against the insects making their way back to permanent breeding areas. They in all probability perish with the coming of cold weather in the same way as the millions of northern drifting cotton moths mentioned above.

The author has given data elsewhere which at least suggest extensive wind-spread, and he is calling attention to this matter at the present time in the hopes that collectors generally will be on the lookout for extralimital insects and thus assist in securing more information concerning this very interesting and important problem. The present indications are that wind-drift in the northeastern United States is mostly from the south and southwest and consequently the taking of species from those areas in the northeastern United States is at least suggestive of extended wind drift. It is felt that enthusiasm in the search for southern and western species in northern United States and southern Canada may yield just as valuable data as the finding of boreal forms on our northern mountain tops.

OBSERVATIONS IN QUEBEC IN 1925

Prof. Georges Maheux, Provincial Entomologist, Quebec.

From the viewpoint of entomological studies the summer of 1925 stands as the most diversified we have experienced for ten years. In midsummer the government officials received many S.O.S. signals from all directions. It was not a case of sudden interest in entomology, but a real symptom of serious troubles. Never to the author's knowledge did Quebec entertain such a galaxy of common and uncommon pests. Our staff, composed of five men, could hardly keep pace with the constant demands from all over the province, and the field men often had to put aside their regular work to lend a helping hand to farmers, fruit or vegetable growers, florists and others. From the records compiled in our office (and which are undoubtedly incomplete) we take the following observations.

Vegetable Garden Insects

Among the well-known pests we had as usual to deal with cutworms, potato beetles and cabbage worms. The worst pest, and the one most generally distributed, was *Psila rosae*, the carrot rust fly. Very serious damages were observed in Quebec district and I have no hesitation in stating that seventy-five per cent. of the crop was destroyed. The injury started early, many fields around Quebec being already lost by the end of July. In that district the amount of damage, though difficult to estimate, was heavy. Rimouski and Gaspé districts were also severely affected during the latter part of August, the average loss being estimated at about seventy per cent. Most of the plants did not reach maturity, leaves dying a full month before the normal period of harvesting.

Second in importance is the onion maggot, *Phorbia ceparum* Mg., with a restricted distribution. But here the pest was rather in a bad position due to the results of a propaganda started two years ago in favour of the sodium arsenate treatment. In order to make the vegetable growers familiar with this poison, we had advertised in the rural press that we would distribute free half-ounce samples of the chemical. The first year only thirty-five growers availed themselves of the offer. Last summer the clerk was kept busy supplying over 500 samples, an indication that our campaign had been successful as was also evident from field surveys.

Amongst other vegetable pests mention must be made of occasional leaf injury to cucumbers made by *Diabrotica vittata* in the Quebec district, and thirty per cent. damage caused by *Phorbia fusciceps* Zett. to young bean plants in Three Rivers district.

Injury to beets in Quebec and Beauce districts due to *Pegomyia hyoscyami* Panzer (spinach leaf miner), chiefly causing a retardation of growth. A carrot aphid not yet identified has entirely destroyed the crops in some gardens at Rimouski.

Barathra occidentata Grote, a noctuid kindly identified by Mr. Arthur Gibson, has been found troublesome in Lake St. John and Quebec districts. It seemed omnivorous and caused much damage to cabbages, raspberries, celery, beans, poplar, asters, poppies and a number of other plants. At Grande Baie, near Chicoutimi, this pest attacked nearly every growing plant in gardens and groves. Never before had this insect been so numerous and so destructive.

The pea-louse was very active in Montreal district. Entire fields of peas were seriously affected by *Macrosiphum pisi* Kalt. In some instances the loss was very high. The upper part of corn plants, especially the tassel, was, in

Portneuf county, visited by a grayish aphid; damage was rather light. The corn ear-worm, *Heliothis obsoleta*, was locally injurious throughout the western part of the province.

Orchard Insects

Aphids were very numerous even in some sprayed orchards where spraying started too late. This experience goes to show that applications for aphid control should commence with the first spray if good results are expected. We have inspected in August nurseries very seriously affected with this pest though the young seedlings were carefully sprayed every ten days with nicotine sulphate, but control measures did not start before the end of June.

Apart from these sucking insects, *Saperda condida* Fab. appeared to be very active this season in many districts.

Some isolated cases of infestation by *Schizoneura lanigera* Haus., *Schizura concinna* S. and A., *Hyphantria textor* Harris, were also recorded.

Small Fruit Insects

The chief offenders in this group were *Myzus ribis* L. and *Pteronus ribesii* Scop., both very widely distributed, very active and injurious. Of course, the currant aphis gave more trouble, its attack lasting all summer. The imported currant worm is always the most surprising pest in the small garden. In fact, I do not know of many small-garden owners who do not wait until seventy-five per cent. of the foliage has been devoured before taking advantage of any insecticide.

Shade and Forest Trees

Quebec has experienced this year a very severe attack from the birch leaf skeletonizer, *Bucculatrix canadensisella* Cham. This general outbreak of a rather uncommon pest covered the districts of Quebec, Sherbrooke, Three Rivers and the whole territory between. An average of three larvae per leaf was found at Deschambeault with ninety per cent. of the leaves affected. Species of birch affected were mainly *Betula nigra* and *Betula populifolia*.

Second in importance was *Paraclemensia acerifoliella* Clem., the maple leaf cutter, which continued last season the destruction started three years ago in the district of Montreal on *Acer saccharum*. The outbreak was severe throughout the district. It will be interesting to follow the growth of these maples after two or three successive attacks.

We also have records of occasional attacks by *Hemerocampa leucostigma* S. and A. (on *Salix* and *Acer rubum*); *Hemerocampa definita* Pack. (on *Ulmus* and *Populus*); *Vanessa antiopa* L. (on *Ulmus*); *Datana ministra* Dru. (on *Populus tremuloides*).

In the Provincial Nursery at Deschambeault we observed a large, dark-brown aphis affecting the twigs, branches and trunks of golden willows (*Salix aurantiaca*). On a particular tree the bark could hardly be seen, so numerous were the aphids.

I have also observed local infestations of basal leaf galls caused by *Pemphigus populicaulis* Fitch on *Populus tremuloides*. In the Eastern Townships some trees were so completely affected that one healthy leaf could hardly be found.

Flower Plants

The noctuid *Barathra occidentata* Grote was very bad in some isolated cases. Asters, poppies, dahlias and other plants were entirely defoliated by the pest by the middle of August. In one instance at least, *Macropsiphum rudbekiae* Fitch caused much damage to Rudbekiae.

Reviewing the whole season we come to the conclusion that the most important entomological feature was presented by plant lice; they showed considerably increased numbers, a variety of seriously affected host plants, and in most cases very unexpected outbreaks.

INSECT PESTS IMPORTED ON MISCELLANEOUS PLANT PRODUCTS

R. A. Sheppard, Entomological Branch, Niagara Falls, Ont.

Although, perhaps, not generally considered a serious source of danger as carriers of insect pests, miscellaneous plant products, not covered by any restrictive regulations, are undoubtedly responsible for the importation of many unwelcome and injurious insects, some of which, under favourable conditions, might prove extremely dangerous.

In this paper it is my intention to give an account of the insects collected from shipments of plant products of a widely divergent nature which have crossed the border at Niagara Falls, by road or rail, during the last two years.

Contrary to expectations, more interceptions of insect pests have been made in autumn and winter than in spring and summer. This appears to be largely due to the increased importations of plant products generally in the former seasons and to the somewhat heavy movements of the products of European fields and orchards during the few weeks preceding the Christmas season.

It will be noticed that, with the exception of the scale insects, belonging to the Homoptera, only two orders are represented in these collections, namely, Lepidoptera and Coleoptera, two great orders to which belong the majority of our most serious pests of field, garden and stored products.

Ephestia cautella, Walk. (The Fig Moth.)

Both larvae and cocoons of the fig moth have been found alive on several occasions in boxes of shelled almonds from Spain. In no one of these consignments was the percentage of infestation very heavy, being in general something in the neighbourhood of one percentum, or even less, of the entire shipment. Larvae of this moth have also been found in shelled Spanish peanuts consigned to Kingston, Ontario, from a firm in Indiana, U.S.A., and once in peanuts, in the shell, originating in North Carolina, U.S.A.

Ephestia kuehniella, Zell. (The Mediterranean Flour Moth).

A considerable number of live larvae and cocoons of the Mediterranean flour moth were found, in January of this year, in one bag of a large shipment consisting of eighty-seven 100-pound bags of dried chilies from Uganda, East Africa, consigned to a firm in Winnipeg, Manitoba. These specimens were somewhat difficult to collect due to the almost overpowering strength and peppery nature of the chilies, which made it practically impossible to stay in the car with the

shipment for more than a minute or two at a time and brought on a violent fit of sneezing whenever a bag was opened or even moved. One solitary larva, intercepted in a small shipment of beans from Italy, in March of this year, was reared in the office at Niagara Falls and the moth later identified in Ottawa as of this species, and one of two larvae collected from a consignment of black-eyed beans, imported from the United States in July of this year, was also reared at Niagara Falls and identified in Ottawa as the Mediterranean flour moth. Dead and damaged unidentified *Ephestia* larvae and cocoons, probably referable to this species, have been found, on more than once occasion, in boxes of shelled almonds from Spain, and once a small quantity of *Ephestia* silk and castings were found in a shipment of cocoa beans originating in Brazil, but unfortunately nothing sufficient for a definite identification was turned up.

Plodia interpunctella, Hb. (The Indian-meal Moth).

A one percentum infestation of the larvae of the Indian-meal moth was intercepted, in October of this year, in a shipment consisting of twenty-five 28-pound boxes of shelled almonds, of Spanish origin, consigned to a firm in Toronto from New York city, and in the early part of November of this year an empty cocoon and one solitary, somewhat damaged, larva which appeared to be referable to this species, were found in a shipment of Lupin beans from Italy.

Myelois ceratoniae, Zeller (————————————)

In the latter part of November of last year one live larva and three cocoons were intercepted in a large consignment of shelled almonds from Spain, consisting of thirty bags weighing two hundred pounds each. In three of the bags traces of infestation by a Lepidopterous insect were noted, but the four specimens mentioned above were the only ones that could be found. These were submitted to Ottawa for examination and were, at first, referred to the *Ephestia* group, but later were reared and identified by Dr. J. H. McDunnough as belonging to this species. This interception constitutes, we believe, a new record for Canada.

Carpocapsa pomonella, L. (Codling Moth).

Larvae of this common pest have been found on one occasion only, and that was in a consignment of pears imported from Lewiston, New York State. The explanation for this solitary interception is probably due more to the comparatively small quantities of pears and apples available for inspection at this port than to any other reason.

Prodenia commelinae, Abbot and Smith.

In February of last year a full-grown larva of this species was found in a very active condition in a crate of fresh tomatoes from Florida which had been purchased on the Buffalo fruit market and imported by a local dealer.

Hellula undalis, Fab. (The Cabbage Webworm).

Three live larvae of this species, in an active condition, were found in January of this year in a crate of fresh spinach originating in Texas and imported by a local firm from the Buffalo market.

Vitula sp. (——————————).

Two *Phycid* larvae, possibly referable to this genus, were found alive, on the 18th of January last year, in a shipment of bamboo poles from Japan, consigned to Toronto by a New York city firm. One larva was found inhabiting a boring in the bamboo and the other was spun up in silk in the hollow end of one of the poles.

In addition to the above-mentioned species, unidentified live and dead Micro-Lepidopterous larvae and cocoons have been intercepted in sunflower seed from the Argentine; two live Micro-Lepidopterous larvae were found in a shipment of black-eyed beans from the United States, imported, in July of this year, by a Toronto firm, and dead and dilapidated Lepidopterous larvae have been found on more than one occasion in locust beans, known as St. John's Bread, from Italy. Many signs of a former infestation of leaf-miners and leaf-tyers have been noted in shipments of senna leaves from India and from Africa. Dead and dilapidated Lepidopterous cocoons and pupae cases have frequently been found in old borings in the dried reeds, known as Cooperage flags, in consignments of this commodity from New York State, but, unfortunately, up to the present time nothing sufficient for an identification has been secured. On one occasion a small, empty Lepidopterous cocoon was found in a boring in a dried stalk of Cannabis herbs in a shipment imported by a Toronto firm from the United States, and signs of a former infestation of both Lepidopterous and Coleopterous larvae have frequently been noticed in shipments of sunflower seed from Russia. Also one shrivelled, unidentified Lepidopterous larva was collected from a small shipment of dried Lobelia herbs from the United States, in March of this year, and empty and dilapidated Lepidopterous cocoons were once found in matted clumps, containing a certain amount of dried earth, of gentian root in a consignment, probably of French or Belgian origin, shipped to Toronto by a New York city firm.

Mylabris pisorum L. (The Pea Weevil).

Nine dead beetles and about the same number of dormant larvae were found, in January of last year, in a large consignment of dried garden peas, shipped to an Oshawa firm from Syracuse, New York State, and *Mylabris* weevils of this or a closely allied species were intercepted in a small shipment of vetch seed originating in Holland and consigned to London, Ontario, by a New York city firm in the early part of last year.

Mylabris rufimanus, Boh. (The Broad-bean Weevil).

A two percentum infestation of live adult broad-bean weevils was intercepted, in December of last year, in a shipment consisting of five 120-pound bags of fava beans from Pasadena, California, consigned to a Toronto company. Unidentified dead weevils, possibly referable to this or to the preceding species, were found on several occasions, during January and February of this year, in consignments of broad and fava beans from Holland, and on one occasion dead *Mylabris* larvae were collected from a small shipment of black-eyed beans consigned to a Toronto firm from New York city.

Mylabris sp. (—————————— Weevil).

In January of last year two dead *Mylabris* weevils were collected from a small shipment of spring vetch seed originating in Holland and consigned to

London, Ontario, by a New York city firm. When these specimens were submitted to Ottawa for examination they were thought to be probably new to Canada, but owing to insufficient material a definite identification could not be made.

Lasioderma serricorne, Fab. (The Cigarette Beetle).

Live larvae, pupae and adults of the Cigarette beetle were intercepted on two occasions; this last autumn, in small consignments of ginger root from Jamaica, British West Indies. One shipment, examined in the month of September, consisting of one bag weighing 112 pounds, was found to be infested to the extent of two percentum of the whole, whilst the other shipment, which crossed the border at a later date and was of exactly the same size, only gave an infestation percentage of approximately one-half of one percentum. It appears that ginger root is a rather unusual host for the cigarette beetle and that this may possibly be the first recorded instance of this insect attacking such material.

Languria augustata (——————— Stem-borer).

Dead specimens of this stem-boring beetle, both larvae and adults, were found occupying borings in the dried stalks of a shipment of lobelia herbs imported from the United States by a Montreal firm, in July of last year. On several other occasions borings have been noted in the stems of dried lobelia herbs, but up to the present time no other specimens have been secured.

Platypus sp. (——————— Pin-hole Borer).

About a dozen or more adult beetles and a few larvae, referable to this genus, were found alive under the bark and inhabiting borings in lignum vitae logs from Nicaragua, shipped in the rough state to the Hydro-Electric Power Commission's generating station at Queenston by a New York firm. Some of the borings made by this beetle had penetrated an inch or more into the hardwood and to obtain good specimens of their work it was necessary to use a special metal saw and a cold chisel.

Xyleborus sp. (——————— Bark Beetle).

Two live specimens of a bark beetle belonging to this genus, but unidentified as to species, were found under bark and collected from the Nicaraguan lignum vitae logs referred to above in connection with the *Platypus* beetle.

Dermestes sp. (Larder(?) Beetle).

A few live *Dermestes* larvae, undetermined as to species, were found this autumn in one bag of a shipment, consisting of three 100-pound bags, of aniseed from Russia. This is a genus which one would expect to be fairly frequently represented in collections of pests from imported plant products, but for one reason or another this happens to be the only interception of *Dermestes* that we have made at Niagara Falls.

Cerambycid Beetles (Round-headed Borers).

Both live and dead round-headed borer larvae, unidentified as to genus or species, have been found on three separate occasions under bark on logs of lignum vitae wood from Nicaragua and other Central American countries.

Buprestid Beetles (Flat-headed Borers).

A twenty percentum infestation of live flat-headed borer larvae was intercepted, in September of this year, on a shipment consisting of fifty-six small logs of lignum vitae wood consigned to Quebec, P.Q., by a New York city firm. These borers were found tunnelling between the under side of the bark and the sap wood, and about three dozen specimens of the larvae, together with specimens of their work, were collected and forwarded to Ottawa.

Cucujid Beetles (Bark Beetles).

Live specimens of *Cucujid* bark beetles, unidentified as to genus or species, were collected from a log of lignum vitae wood originating in Nicaragua, forwarded, during the month of October last year, to the Hydro-Electric Power Commission at Niagara Falls by a New York city firm.

Both live and dead unidentified Coleopterous larvae, in addition to those enumerated, have been intercepted in sunflower seed from Russia, in sunflower seed from the Argentine, as well as in broad beans and in lupin beans from Italy, and numerous traces of what appeared to be a former infestation and damage by weevil have been noted on many occasions in shipments of black-eyed beans and shipments of chick peas from the United States.

Lepidosaphes ulmi, L. (The Oyster-shell Scale).

Considerable quantities of this scale have been intercepted quite frequently in consignments of dried bark from the United States and on more than one occasion shipments of cascara bark from the same country have been found to be heavily infested with this common pest.

Aonidia lauri, Bouche (————————————).

On three separate occasions this scale has been intercepted in shipments of bay leaves from Italy, but in no one of the three consignments was the percentage of infestation very heavy.

Traces of a former infestation and damage by insect pests, probably Coleopterous or Lepidopterous, have been noted in coriander seed from India, in Chick peas from Algeria, in locust beans from Italy, on several occasions in barrels and bags of chestnuts from Italy, and in shipments of lima beans, in cow peas and in chick peas from the United States. Also minute borings have occasionally been found in rattans from the Dutch East Indies, and on one occasion last year, in a consignment of dried reeds, known as cooperage flags, from Charlotte, New York State, a considerable number of old borings were noted, but a careful search failed to reveal anything in the way of insect specimens except some empty and broken Dipterous pupae cases.

SOME INSECTS AND ENTOMOLOGISTS

W. E. Britton, State Entomologist of Connecticut

When your Dominion Entomologist paid me the compliment of inviting me to give this public address, I was somewhat at a loss to know just what subject to select. Many other addresses have been given in former years and the same ground must not be covered. On consulting your reports I learn that two years ago, my good friend, Mr. A. F. Burgess, gave you an excellent account of the "Value of Natural Enemies of Insect Pests," and that last year Professor C. L. Metcalf gave you a very complete classified account of the methods used in the "Warfare Against the Insects." As I see it, there are two chief requirements which I must hope to meet in this address: (1) I must interest you, and (2) it must contain enough meat so that you will not go away feeling that entertainment was the only object in view. I have, therefore, chosen this subject because it will include anything which I may wish to say, and there is a possibility (which is rather remote in my case) of making it both entertaining and instructive. With your permission, I will attempt to point out some of the needs and tendencies in the progress of entomology, and will mention some of the men who have been responsible in shaping its growth and development.

Pioneers in America

First of all I wish here to pay a tribute of respect and appreciation to some of the pioneers of entomology in Canada and the United States. L'Abbe Provancher must have done a tremendous amount of work, especially in the Coleoptera and Hymenoptera, and though I am not an authority in either order, I know that his descriptions were sufficiently good so that most of his species can be recognized, and his names hold. We look upon him as the Thomas Say of Canada. Years ago I had the pleasure of meeting Doctors William Saunders and James Fletcher. Dr. Saunders performed a great service by publishing his articles on insects and particularly his "Insects Injurious to Fruits," which was the standard work on the subject for a generation, or until the arrival of Slingerland and Crosby's Manual of Fruit Insects, in 1914. Dr. Fletcher, whom some of you knew and worked with, was a big-hearted lovable man, who was Dominion Entomologist and Botanist from 1887 until his death in 1908. I never saw greater enthusiasm nor more ability to interest an audience than he possessed. Dr. Fletcher was an all-round naturalist and was quite as much of a botanist as an entomologist, but first and most of all he was a man. It was my good fortune to know and admire his successor, Dr. C. Gordon Hewitt, from the time he became Dominion Entomologist in 1909 until his untimely death in 1920. Few scientists are equipped with such a brilliant intellect as was Dr. Hewitt, and when combined with his unusual executive ability and thorough training, this made him a peculiarly exceptional leader of his time, and he was so recognized throughout America and Europe. It was through his efforts that his department was raised to that of a Branch, and the force consisting of one assistant and one stenographer increased to its present size, with several divisions and field laboratories.

I used to meet Mr. H. H. Lyman at our entomological meetings and formed a high opinion of him. I think I never had the pleasure of meeting Messrs. W. H. Harrington, F. H. Wolley Dod, or Rev. Thomas W. Fyles, though I am familiar with their writings and had some correspondence with Mr. Fyles. Though still living, to a former generation belongs Rev. C. J. S. Bethune, who did much by his

teaching and writing to awaken interest in and promote the knowledge of entomology. His long period of service, covering more than forty years as Editor of *The Canadian Entomologist*, entitles him to a place among the pioneers.

To the younger entomologists of Canada who have fallen by the wayside and to those who are still carrying the torch, I also pay a merited tribute, but to mention them all would transcend the limits of this address.

In the United States, one of our earliest systematic entomologists was Thomas Say, called the father of American entomology, who described many species of American insects and published among other papers, that two-volume work known as Say's Entomology, which remains to this day a standard and indispensable part of the library of every working entomologist. Say was born in 1787 and died in 1834. A contemporary of Say was Dr. Thaddeus William Harris, born in 1795 and died in 1856, who soon after Say's death published that classic work on "Insects Injurious to Vegetation," which is still a necessary part of the working library of every entomologist. Harris is called the father of economic entomology in America. Even before the end of Harris' career, Dr. Asa Fitch, in the State of New York, began his studies which were recorded in that series of valuable reports to the State Agricultural Society, and his work led to the establishment of the office of State Entomologist and that long and remarkable series of reports of Dr. Joseph A. Lintner, so ably continued by Dr. E. P. Felt.

Another remarkable series of reports began in 1867 in the State of Illinois, with the writings of B. D. Walsh, followed after Walsh's death by those of Wm. LeBaron, Cyrus Thomas and Dr. S. A. Forbes. Walsh was fatally injured while collecting insects along the railroad tracks; seeing an approaching train, he stepped to one side, only to be struck by another train. One leg had to be amputated, and it is said that when his family condoled with him on the loss of his leg, Walsh replied that it would be very convenient; that he would have a cork leg and could stick pins into it when working on his collection. He did not live long to enjoy this advantage, but died soon afterwards. Soon after the Illinois Reports began, Dr. C. V. Riley, in Missouri, issued the first of his series of nine reports, ever since known as Riley's Missouri Reports, which have been and still are not only essential in the library of every economic entomologist, but are among the most useful part of his equipment. Riley was an indefatigable worker with pen and brush and was very successful in directing the services of others, perhaps not always giving them due credit. Later he was entomologist of the United States Department of Agriculture, and was instrumental in the formation of the Division of Entomology, later to become a Bureau under the leadership of Dr. L. O. Howard. Dr. Riley started the series of bulletins called "Insect Life," published by the Government in seven volumes and general index; he was injured in a bicycle accident in Washington and died in 1895.

The first entomologist of the United States Department of Agriculture was Townend Glover who, during the seventies, wrote a number of papers on the different orders of insects, illustrated with his own etchings. Some of these were published in facsimile of his own handwriting as "Manuscript Notes from My Journal, or Illustrations of Insects." That on the Hemiptera bears the date of 1876, and the plates are beautiful examples of the author's art. It is told of Glover that he boasted that he had never described a single species, yet afterwards it was found that he had done so unwittingly, as one of the species which he had so carefully figured was found to be new, and was accredited to him.

There were many other men who were pioneers: Otto Lugger, in Minnesota; Charles H. Fernald, in Maine and Massachusetts, who specialized with the

microlepidoptera; L. J. LeConte and Geo. H. Horn, who built the foundation for the study of the Coleoptera; W. H. Ashmead, Hymenoptera; D. W. Coquillett, Diptera; and Theodore Pergande, Hemiptera, in the U.S. National Museum; Alpheus Packard, Massachusetts and Rhode Island; A. J. Cook, Michigan and California; F. H. Snow, Kansas; F. M. Webster, Ohio, and Bureau of Entomology; John B. Smith, our greatest authority on the Noctuidae, New Jersey; M. V. Slingerland, Cornell University, Ithaca, N.Y. There were Clemens in Pennsylvania and Kearfott in New Jersey, who described many species of Microlepidoptera; Grote, in Buffalo, N.Y., worked with the Noctuidae; Morris, in Maryland, and Scudder, in Massachusetts, published on the butterflies, and the latter on Orthoptera; Hagen, of Cambridge, Mass., was our best authority on the Neuroptera; other workers in Coleoptera were Melsheimer and Haldeman, of Pennsylvania, and more recently Thomas L. Casey, of Washington, who died in 1925. Dr. Philip R. Uhler, a librarian of Baltimore, Md., was for years our leading Hemipterist. Now we have lost Dr. A. D. MacGillivray, for years a teacher of entomology at Cornell and Illinois and an authority on the sawflies, and even more recently, Dr. W. D. Hunter, for many years Chief of the Division of Southern Crop Insects of the Bureau of Entomology, has passed to the great beyond. Many entomologists of Europe have described American insects, and we are greatly indebted to Baron Osten Sacken and H. Loew for their work on American Diptera, De Saussure on American wasps, and to Linnaeus for descriptions of insects in all orders.

In my own State, Connecticut, with an area of only about 5,000 square miles, have lived a number of entomologists who have done noteworthy work. Edward Norton, a farmer and dairyman in Farmington, described more than 250 species of sawflies and Ichneumon flies, and translated De Saussure's American Wasps; Homer F. Bassett, a librarian in Waterbury, described more than eighty species of Cynipid gall flies and their galls; Dr. S. W. Williston, afterwards a well-known Palæontologist, when living in New Haven, became interested in entomology and published his work on North American Syrphidae, and his "Synopsis of American Diptera," which has been published in three or more editions.

Several great teachers of entomology are still with us, and the names of J. H. Comstock, S. A. Forbes and Herbert Osborn are prominent among the pioneers. Ezra T. Cresson, of Philadelphia, has long been one of our leading Hymenopterists. Many others might be mentioned but time and space forbid. Let us not forget that to this early work we owe more than we realize for the development of our present knowledge of insects. These men laid a solid foundation for the superstructure which is being erected during our generation.

A Glance Backward

When we look backwards thirty years, we can hardly realize conditions then existing. Comstock's "Manual for the Study of Insects" was issued in 1895—just thirty years ago. Prior to its appearance we had, of course, Say's Entomology and Packard's Guide. On injurious insects we had Harris' "Insects Injurious to Vegetation," Mrs. Treat's "Injurious Insects of the Farm and Garden, "Saunders' "Fruit Insects," Weed's "Insects and Insecticides," and Semper's "Injurious Insects" appeared the year before. But of even greater value were Riley's Missouri Reports, Fitch and Lintner's New York Reports, and the Illinois Reports of Walsh, Lebaron, Thomas, and Forbes.

Slingerland was then in the midst of his work which resulted in the publication of those remarkable monographic bulletins on injurious insects published

by the Cornell Station, which stand to-day as models of their kind. His life-history studies will not soon need to be repeated. Of course new control measures will need to be applied to keep up with the march of progress. So far as literature is concerned, the entomological investigator of to-day has a tremendous advantage over that of any former period.

At that time, lead arsenate as an insecticide had just been discovered but not generally adopted. Paris green was about the only stomach poison used though London purple was mentioned in most publications dealing with insecticides. Kerosene emulsion was about the only contact insecticide known.

The connection between malaria and yellow fever and certain species of mosquitoes had not then been discovered.

Starting the Boom

When Clarence Moores Weed first came to New Hampshire from Ohio in 1891, for lack of space elsewhere, he was given a room in the basement. A friend called on him one day and made some allusion to his getting in "on the ground floor." "Yes," said Dr. Weed, "I'm going to begin at the bottom and work up." The study of insects has advanced with enormous strides since that time. Entomology has "worked up." I think that we may fairly attribute much of the interest in the study of insects and the consequent development of entomology to the outbreak of the San José scale in the eastern states during the nineties. Orchardists were truly frightened and feared that their orchards would be wiped out by this pest; they just put their heads together and secured new legislation creating new official positions; state entomologists by the score, nursery and orchard inspectors; asked for appropriations to investigate and administer There were not enough trained men to meet the demands, and many raw recruits were pressed into service. For the first few years, San José scale investigations were carried on in almost every State, and there is no doubt that much benefit resulted; that these researches demonstrated that the scale can be controlled and how to control it. Just about this time along came that little parasite, *Prospaltella perniciosi* Tower, and literally took charge of the San José scale, and for some fifteen years in the States, the scale was not an economic problem. Now the scale has returned in certain fruit-growing sections, and, strange to say, the treatments in vogue fifteen or twenty years ago are now ineffective—new investigations and new formulae are necessary.

But though the San José scale was the exciting cause of this invasion of entomologists, the entomologists did not subside with the scale. Other problems arose which demanded their attention and still demand it. No sooner can we dispose of one pest when along comes another, or two, three or a dozen of them. So it will always be.

Popular Attitude Toward Entomology and Entomologists

In the popular mind, the entomologist and his profession occupy a place of much greater dignity than was the case thirty or more years ago. People have more confidence in him and his work. This is probably due to the efficient work which has been done in economic entomology and particularly to successful efforts at insect control. A large proportion of our people are not particularly interested in an insect problem unless it touches them directly. If their health or property is injured by insects or they are inconvenienced by them, then at once it becomes a matter of vital interest and it goes without saying that the more

insect problems that confront us, the greater will be the interest of the people in entomological matters. If we, as entomologists, show intelligence, aggressiveness, and attack the problem scientifically and logically, there are good chances of success. Consequently, the impression received by the people will be much more favourable if they come in contact with high-grade and well-trained men on the work. Character counts wherever placed, and nowhere will it count for more than in these gigantic control operations.

In ascribing the improved popular attitude toward the entomological profession to the economic entomologist and our large pest problems, I do not for a moment wish to belittle or discourage the systematist as he is a very necessary part of our entomological organization. We often run across injurious insects that are unfamiliar to us, and it is the systematic worker who gives us the proper identification. Yet the classification and indexing of insects does not cover the whole subject of entomology as it once did, and forms even a smaller part of it than a few years ago. Friends often say to me, "I should like to study insects if it were not for the awful names; I could never learn or remember them." I usually advise them that insect names are no worse than plant names; that they need make no effort to learn the scientific names though most of them are Latin and have some meaning, descriptive or otherwise; that they can form a number of pleasant acquaintances with insects as with persons without knowing their names at all; that it is only when they wish to speak or write of them, as with persons, it is necessary to call them by name; and surely insect names are no harder to learn, remember, or to speak than the names of some of our foreign-born human citizens or residents, like Alexander Kantrovitsky or Salvatore Dellarocco. Get well acquainted in other respects and the name will come incidentally, unconsciously, and without effort.

We may perhaps deprecate the prevailing custom both in this country and abroad of classifying insects from the horticultural standpoint as to whether or not they are plant pests, yet this is the standpoint from which most people will review them. Nevertheless, a study of the life history of any insect, whether pest or not, is of much educational value and we should not lose sight of this point.

Present Problems in Entomology

And with the great number of entomological workers at present, what is being done? More careful studies are being made on all groups of insects. Of course the injurious species demand and receive the first attention. The recent introductions must be studied in their new habitat and their adaptations recorded. Their habits, therefore, are of the very first importance, because, until their relations to the new conditions are well known, control measures cannot be more than accidentally successful. And a pioneer pest must of necessity take on new habits to enable it to be a pest at all or even to survive in its new environment. Some of these insects are not well understood in their native lands and in such cases we have little data to guide us as to what we may expect in the new colonies. Here let me point out a weakness in our entomological organizations in America. Though we have received many pests from abroad which are raising havoc in both Canada and the United States, there are still many injurious insects which as yet we haven't got—thank Heaven! Some of them constantly threaten us in spite of our scores of quarantines and embargoes. *Verboten* is almost as common here as it was in Germany before the World War. Yet if the procession moth or the nun moth should appear here next year in

large numbers, we would not be prepared to stamp it out at once. Unpreparedness is the price which democracies must pay for liberty. To make a campaign it requires funds. Our legislators will not make large appropriations unless they can be shown the need of it. Consequently there are seldom reserve funds for such purposes. So for a time vigorous suppressive or exterminative measures are not taken for lack of funds. In case the new insect does multiply rapidly and after a few years causes serious injury, it will be fairly easy to obtain appropriations to fight it. But when that time arrives it may have become so well established and spread over so much territory, that to eradicate it will prove extremely costly if indeed at all possible. This is the way the budget system works, in the States. I hope you may have a better way of doing things in Canada.

If there could be in the Department of Agriculture in Canada and also in the United States a large emergency fund for the very purpose of stamping out each potential and incipient pest which may enter our domains, the ultimate injury caused by introduced pests as well as the cost of controlling such pests, would be greatly reduced. Mr. A. F. Burgess in an address recently emphasized the need of sending trained entomologists abroad to study from the American standpoint some of these pests in other lands which we fear may soon descend upon us. Then, too, there are many insects in other countries which are not there considered as pests and the entomologists there have paid little attention to them. If brought here their record may be very different, like the Japanese beetle, *Popillia japonica*, which is hardly a pest in Japan, but in New Jersey and Pennsylvania is a pest of the first magnitude.

Some of the major insect control problems of the United States are similar to those of Canada; the gipsy moth, brown-tail moth, satin moth, European corn borer and Oriental peach moth occur in both countries, and the best thought and efforts of entomologists of both nations are being devoted to the solution of the problems, and the ultimate control of the pests. On account of the latitude and climate of Canada, you will probably never be worried with the solution of cotton insect problems, like those of our southern states.

The green Japanese beetle, *Popillia japonica*, has taken rank as a major pest in New Jersey and eastern Pennsylvania, covering more than 5,000 square miles, and we greatly fear that it may spread over a wider territory before it can be controlled. Yet we should not despair. Able hands and minds are giving noble service and much progress has already been made. I believe that further progress is sure to follow soon. Yes, it costs a lot of money, but sacrifice has ever been the cost of freedom.

In less than half a decade, I have seen one insect pest, the apple and thorn skeletonizer, *Hemerophila pariana* Clerck, pass through my State leaving every unsprayed apple tree in its wake, brown and sere, then pass on, and in two seasons the trees were green again. This insect moved rapidly northward and possibly may have reached Canada ere this—I do not know how far in has spread. Traces are still to be found in nearly every orchard in Connecticut, but in most cases the injury amounts to nothing. What we feared to be a serious problem was solved for us by nature.

The Oriental peach moth, *Laspeyresia molesta* Busck, now appears on the horizon as a very important menace to our orchard industry, and the application of insecticides has not been very effective. Recently it has developed that the adults are attracted by sweetened baits and can be caught in large numbers in orchards, and this seems a promising lead toward some means of control.

An extremely important development of recent years is this series of experi-

ments with baits to attract insect pests. When we learn intimately the habits of insects, their preferences and their dislikes, their seasonal appearances, their daily schedule and feeding habits, then we are in a much better position to develop satisfactory methods of control. At present we are progressing in the control of the gipsy moth, chiefly through the adoption of better methods and through the importation of natural enemies. Through the balloon experiments of Dr. Felt, we now have some means of ascertaining the probable occurrences of wind-spread without searching all over the surrounding territory and expending one or two years of time to detect it.

At present in Connecticut we have two introduced pests which probably do not occur in Canada. One is the Asiatic beetle, *Anomala orientalis* Waterhouse, the grubs of which eat the roots of grass. It is now known to occur in the United States only in the western part of the City of New Haven, where it has injured many lawns during the past three years. Little injury was noticeable during the first half of the summer of 1925, but in August and September complaints were received by the score, and more injury was apparent than ever before. Mr. Loren B. Smith of the Japanese Beetle Laboratory, Riverton, N.J., was sent by the Bureau of Entomology at my request to survey the situation and make a report. He states that the injury to lawns as he saw it is fully as serious as any similar injury which has ever been caused by the Japanese beetle, *Popillia japonica*, though the adults of the latter seriously injure foliage and fruit. The present area where injury occurs is within about one-fourth of a square mile (or about half a mile in each dimension) and includes some twenty-seven city blocks where the holdings are practically all fifty and seventy-five foot lots, each with a dwelling house, mostly of the one-family type. The insect has a generation each year and the adults fly and feed very little. Mr. Smith believes it possible to exterminate this insect, and recommends attempting it at a cost of about $25,000.00. He believes that this insect is near the northern limit where it can survive, but that it might prove a very serious pest to various crops if it should spread further southward. Probably it was brought into Connecticut in balls of earth on nursery stock from Japan prior to the time when the Federal Horticultural Board prohibited such importations in 1917. *Anomala orientalis* caused much damage in Hawaii ten years ago by eating the roots of sugar cane, but a parasite, *Scolia manilae*, was introduced which proved so effective in suppressing it that on an area where 3,500 grubs were found in 1917, only four were discovered in 1919. *Scolia manilae* has already been brought into New Jersey as a possible parasite for the Japanese beetle, but does not withstand the winters. Mr. Smith informs me that though this *Anomala* occurs in Japan, it came originally from the Philippines.

Probably if funds can be raised we shall make an attempt to eradicate it by treating the entire surface of the area next spring with carbon disulphide emulsion according to Mr. Smith's recommendations, the work to be done co-operatively by the Bureau of Entomology and by the State. Whatever the outcome of this attempt, the results will be watched with interest.

The other pest which I mentioned is a sawfly leaf-miner of birch, *Fenusa pumila* Klug, from Europe. Mined leaves were first noticed in 1923 on the tips of the sprout of grey birch, and the following season the adults were reared and identified. This season we have made some observations on its life history and habits. In Connecticut there are at least three broods each season and a partial fourth brood. Though usually injured leaves are mostly near the ground, some have been noticed as high as fifteen feet. It also attacks European white birch and paper or canoe birch. Whether or not it will become a pest is yet to be

determined, but it is extremely abundant on the young sprouts on cut-over land. It is now present throughout Connecticut, Rhode Island, Massachusetts, eastern New York, and in Vermont at least as far north as Rutland.

Thus you see there are many new pests that must be studied and overcome. Some of the old ones must be studied again in the light of our present knowledge and experience. New insecticides are constantly being brought out and some of them are sure to be of great value, but we must not depend over-much on them. Rather should we seek a more intimate knowledge of the habits of the insects to find a more vulnerable point, or a more advantageous time to attack them.

Considerable progress has already been made in the development of improved machinery for applying sprays and dusts, and more improvements are sure to follow. The aeroplane will doubtless be utilized in many cases where large areas of a single crop or where a forest is to be treated. Likewise cultural practices must be worked out to reduce damage by insects.

Medical Entomology

I can hardly make an address of this kind without some reference to the important discoveries of the last thirty years in the transmission of certain human diseases. These include the transmission of malaria by the bites of mosquitoes of the genus *Anopheles*, yellow fever in the tropics by the bites of *Aedes argenteus*, typhoid fever and house flies, typhus fever and cooties, sleeping sickness and the tsetse flies in Africa, and many other revelations. Surely no man deserves greater honour than those who, like Doctors Reed, Lazear and Gorgas, have devoted their lives to such work for the benefit of mankind. This is a fertile field for well-trained entomological endeavour and he who cultivates it after planting the seed is bound to reap a harvest.

Aside from their connection with disease, mosquitoes are a nuisance and from the standpoint of comfort alone they should be controlled around all centres of population. The State of New Jersey has probably taken the lead in this work and great benefits have already accrued. The people take greater comfort, more homes are builded, and property values have increased.

Though Connecticut has a much smaller salt marsh area and its problem is correspondingly smaller, a good start has been made and about one-third of its salt marshes have been ditched. Another town has recently voted funds for this purpose. I expect to see more of this work done, especially around the more densely populated areas of the United States and Canada.

Entomological Societies

I rejoice in the great number of enthusiastic well-trained young entomologists in Canada and the United States. It augurs well for both the future of the profession and for the welfare of mankind. Associations like the Ontario Entomological Society are productive of great good because they bring the workers together where they can exchange ideas and observations. The great American Association of Economic Entomologists now has about 800 members. There are other entomological societies and associations, some of which are not strictly economic in character, and each has its own membership. The total of these not included in the 800 mentioned above is hard to estimate, but quite large I am certain; perhaps as large again.

I think we can hardly overestimate the value to entomology of the smaller associations such as exist in your provinces, in some of the United States, and

grouped around certain centres where large control operations are being carried on. Even municipal societies where a sufficient number having a common interest can come together are advisable. Interest rather than numbers should be the criterion. Some of these smaller meetings are very interesting, they are less formal than the larger gatherings, the workers can become better aquainted and they give an opportunity for many men and especially the young men and those not holding official positions to attend, who could not go except very rarely to a national meeting. Let us therefore encourage the formation of local associations, and the holding of group meetings. I believe that we have demonstrated it to be well worth while.

In concluding, let me state that I believe that more and better work is now being done than ever before and this is partly because of the foundation laid by the pioneer workers, and in part by the keen competition and the better training of the men. The large number of serious insect problems has attracted public attention to the needs of entomologists and to the importance of their work, and a fair degree of public support is now assured.

There remain many problems to be solved, but there is a regiment of keen workers ready to undertake their solution. We may look forward therefore with confidence that the future will bring even greater achievements than the past. If some do not reach their objectives during the first onslaught, they should remember the Englishman's motto, "It's dogged as does it," and go at it again. Persistence and the right spirit will conquer worlds.

CONTROLLING THE BROWN TAIL MOTH IN NOVA SCOTIA

F. C. Gilliatt, Dominion Entomological Laboratory, Annapolis Royal, N. S.

As soon as the brown tail moth was discovered in Nova Scotia in 1907, a number of inspectors were placed in the field by the local Department of Agriculture. During the first few years, owing to this pest being a new introduction, various control measures were adopted, viz., collecting the winter webs; spraying scrub areas with a hand outfit where larvae were noticed to be feeding; a bounty of three cents, afterwards increased to ten cents per web, being paid by the local Department. This latter method was taken advantage of by unscrupulous people, and soon had to be discontinued as impracticable, though it was the means of gathering in a quantity of webs which otherwise would never have been destroyed.

The local Department carried on this inspection work until the year 1910, when through the influence of the late Dr. C. Gordon Hewitt, then Dominion Entomologist, the Federal Department co-operated. The work at this time was reorganized, the Dominion Entomological Branch assuming charge of it, with the local Department of Agriculture supplying one-half of the men employed during the inspection season. This co-operation between the two Departments was continued until 1924, when the Provincial Department decided that they were unable to maintain their part of this inspection. During last season, or that of 1924-25, the work was conducted entirely by the Dominion Entomological Branch.

At the beginning of this work in Nova Scotia, only two inspectors were employed for a portion of the winter months, but at the time of reorganization

in 1910 the number was increased to six, working for a period of six months. The area inspected included the territory from Windsor to Yarmouth, with considerable scouting in other parts of the Province.

There was a marked increase in the number of winter webs collected during the seasons between 1908-1909 and 1913-1914, as the former numbered only 800 and the latter totalled 24,156 webs. The number of inspectors had to be increased to ten, and the infested area included more than one-half of the Province. In spite of the strenuous efforts put forth by these ten inspectors, the prospect was far from promising and in every way the pest threatened to become as serious in Nova Scotia as it already was in the New England States.

Then came a change in the status of the brown tail moth situation in Nova Scotia. From the zenith year 1913-1914, with its webs numbering 24,156, there has been a gradual decrease, with but slight variations, down to the last season, showing only 154 webs. Necessarily following this has been a reduction in the number of inspectors employed and a corresponding decrease in the expense entailed.

We cannot definitely state, just why this moth was difficult to keep in check, and why increases occurred each year for about the first eight years after its introduction into Nova Scotia. It has, however, apparently lost its virulence in a comparative degree. Probably the result is not due to any one particular influence or factor but to the various agencies working together, which menace, more or less, the existence of this insect.

The following discussion may throw some light upon this subject, and at the same time explain what has been done in Nova Scotia by the Entomological Branch to assist in combatting this serious pest.

Parasites Introduced

In the spring of 1913, 7,000 *Apanteles lacteicolor* cocoons were received from Melrose Highlands and liberated in infested areas. To prevent these parasites being destroyed along with the brown tail moth winter webs, three large cages, twelve feet by six feet by five feet, were erected in these areas. Two rows of tanglefoot were placed around the cages on the inside with a projecting board on top, thus making a very large Fiske tray. In the following spring, 6,000 brown tail moth webs were placed in each of these cages, the larvae fed daily until the *Apanteles* emerged, after which the brown tails were destroyed. A very large number of *Apanteles* emerged, and Mr. G. E. Sanders, who had charge of the work at this time, estimated that 20,000, 20,000, and 100,000 *Apanteles* cocoons respectively were to be found in each cage. These figures, though probably over-estimated, show that this was a very effective and inexpensive method of rearing and liberating this parasite. These cages were maintained for a number of years, similar ones built in other localities, but owing to the great reduction of webs some of the cages were discarded and none have been used since the season of 1922.

A very systematic recovery for *Apanteles* was conducted at the Fredericton Laboratory during the years 1917, 1918, and 1919, from webs collected at fifty-five localities in Nova Scotia. The result revealed that twenty-seven places gave no parasites, numbers recovered from other localities gave as high in one case as 12.25 *Apanteles* per web, but many averaged less than one per web.

In 1913, there were received 1,500 puparia of *Compsilura concinnata* from Melrose Highlands, also twenty-two from Wellsby, which were liberated at Bear River. In 1915, there were received 1,500 more from Melrose Highlands

and liberated at Annapolis Royal. It is interesting to note that a few years later two *Compsilura* were recovered from brown tail moth larva collected at Annapolis Royal.

During the spring of 1914, 600 *Calosoma sycophanta* were brought to Nova Scotia from the New England States. These were divided into lots of one-hundred and liberated at various places in the infested area. No systematic attempt was ever made to recover this beetle in Nova Scotia. A few years after its introduction, however, circulars were distributed among farmers, schools, etc., showing clearly the value of this predator, and asking for specimens for identification, but no specimens were ever received.

Native parasites were recovered in 1913, from Bridgetown and Annapolis Royal, including Braconids and Tachnids, thus indicating the possibility of native parasites attacking this insect.

Fungous Diseases

In June, 1912, a quantity of brown tail moth larvae were received from Melrose Highlands, affected with *Entomophthora aulicoe* and placed among American and forest tent caterpillars in our infested areas. In the following year a fungous disease was noticed killing tent caterpillars in rather large numbers. This fungus, however, was identified by Dr. Thaxter as a species of *Empusa*. The spreading of most fungous diseases is largely dependent upon weather conditions, a warm damp atmosphere being the most favourable, thus making this method of control a rather uncertain one, especially in some seasons. The further introduction or spreading, therefore, of fungous diseases for control of this insect was not undertaken.

Climatic Conditions

The climate of Nova Scotia has a marked effect upon this insect. It is known that our lowest temperatures cause the death of a considerable percentage of the over-wintering larvae in their webs. The temperature, however, is not the only factor causing this mortality, humidity doubtless having a certain effect along with low temperatures.

Winter webs were exposed in ten different localities over the Province in 1913-1914, with the following results:

Locality	Percentage mortality	Lowest temperature
Yarmouth	52	– 6.4 F.
Bridgetown	45	–19
New Germany	100	–27
Parrsboro	96	–21
New Glasgow	57	–19.5
Antigonish	66	–20
Truro	100	–24.6
Halifax	25	–13
Windsor	55	–18.5

One interesting item in this list is, that at Yarmouth other factors besides temperature had an adverse effect. It is well known that in Yarmouth the humidity is high. A temperature of –6.4 degrees Fahrenheit in the Annapolis Valley practically has little effect upon mortality, whereas this temperature gave a higher percentage of control than –19 degrees Fahrenheit at Bridgetown.

Notice, also, that −25 degrees Fahrenheit or over, if lasting for any length of time, usually gave 100 per cent. control. This mortality has been borne out by further exposures in later years.

Collecting Winter Webs

Probably no single factor has been as effective in the suppression of this insect in Nova Scotia as the collecting of the winter webs, especially during the first few years of its introduction. If the Dominion and Provincial Departments had not so rigourously pursued their methods of eradication, it is difficult to say how firmly this pest might have established itself in our Province.

The collecting, however, has more significance than the mere destruction of the webs. In the badly infested areas the policy pursued has been to work and rework until it would seem as if every web was gathered. If, unavoidably, any are left, they are of necessity the small inconspicuous ones. These small, weak webs being largely the only means of perpetuating the species, the writer is of the opinion that this has been deteriorating to this insect. The webs collected the last few years have been noticeably smaller than ten or fifteen years ago. It is also rather significant that where this pressure, so to speak, has been maintained the longest in the old and worst infested areas in Yarmouth, Digby and Annapolis Counties, these were the first to be entirely eliminated of this pest. As the smaller webs are more easily affected by sudden, severe winter changes, and an easier prey to parasites and birds, we know that the mortality of caterpillars in such webs is greater than in the larger ones.

Webs were exposed during the winter in Wolfville and Annapolis Royal with the following results:

Locality	Year	Character of Web	No. alive average of all webs exposed	No. dead average of all webs exposed	Percentage Mortality	Lowest Temperature
Wolfville..	1924–25	Small	31.6	24	40.4	−22.5 F.
"	"	Medium	154.6	5.7	3.3	"
"	"	Large	295.2	13.2	4.2	"
Annapolis.	"	Small	30.5	37	53.3	−12.5 F.
"	"	Medium	103.5	39.5	24.5	"
"	"	Large	282	50.9	15.2	"

Other webs were opened and counted from time to time throughout the winter of 1924-1925.

No. Nests	Collected at	Date Examined	Character of Web	No. Alive	No. Dead	Percentage Mortality
1	Wolfville..	Feb. 11	Medium	194	6	3
1	Round Hill	" 10	Large	220	84	24.3
1	"	" 10	Small	30	67	69
1	Wolfville..	" 23	Large	420	24	5.4
1	"	" 23	Small	2	91	97.9
1	Round Hill	Mar. 6	Large	320	13	3.9
1	Bridgetown	" 5	Small	0	26	100
1	"	" 5	"	0	39	100

These figures are self-explanatory, clearly indicating that the small webs with few cells are adversely affected in comparison with the larger ones with many cells. It is therefore apparent that this artificial work has farther underlying results than just the gathering of, say, ninety-five per cent. to ninety-eight per cent. or more of the winter webs. *If* these small webs produce weak progeny which in turn again produce a small web, then this insect is placed at a decided disadvantage and its existence menaced.

Spraying

Spraying is undoubtedly an important factor in the suppression of this insect.

The worst outbreaks have always been in villages and outlying districts where little spraying, if any, is done, and these have been the most difficult to eradicate.

Conclusion

The natural and artificial agencies herein discussed have assisted in the brown tail moth problem in Nova Scotia.

Besides the collecting of the winter webs by the Entomological Department, assistance has been given natural agencies to make them more operative by the introduction of parasites, fungous diseases, etc. From a peak of nearly 25,000 webs in 1913-1914, the pest has declined to less than 200 in 1924-1925.

Contrast our conditions with the infested areas in the New England States from the time of its introduction in 1907 to the present time. No defoliation in Nova Scotia has ever been observed, not a dollar's worth of damage done, no doubt due in a great measure to the very vigorous campaign waged to keep the pest under subjection.

THE GYPSY MOTH SITUATION IN QUEBEC

L. S. McLaine and S. H. Short, Entomological Branch, Ottawa.

At the last meeting of this Society a short paper was presented in which was reported the finding of an outbreak of the gypsy moth at Henrysburg, Quebec. Owing to the lateness of the season at the time the discovery was made, it was not possible to furnish any details in regard to the infestation. Over a year has now elapsed since the gypsy moth was found and it may be of interest to review briefly the general situation. Although headway has been made in the control of the pest itself, no conclusive evidence has been produced which would lead to the solution of the cause of the outbreak. The theory advanced in the paper presented last year appears to be as plausible as any, namely, "that the pest may have been introduced by infested materials brought by relatives on a visit to Lacolle (Henrysburg) from the infested area in the United States."

The immediate steps to be taken in the control of an outbreak of the gypsy moth depend upon the season of the year at the time the discovery is made and the stage in the cycle of the life history of the insect.

Egg laying was practically completed when the scouts discovered the gypsy moth at Henrysburg on September 3rd, 1924, and steps were taken to obtain the necessary material to treat the egg clusters found and gather together a sufficiently large force of men to cover as much ground as possible before the

winter closed in. The institution of extermination measures in connection with the outbreak of any pest are of necessity much more elaborate and expensive than is the case in carrying on so-called economic control. The finding of an isolated infestation of the gypsy moth in Canadian territory warranted the taking of all reasonable measures and the expenditure of the necessary funds to eradicate the pest. This point was realized not only by the Federal Department of Agriculture but also by the Province of Quebec, who co-operated in the work by supplying both men and money.

During the fall season of 1924 the entire area within a radius of two miles of the centre of the outbreak was scouted and rescouted, stone walls were torn down and rebuilt, old apple trees were cut down; others were pruned, trimmed and old cavities filled; brush was cut and burnt; fence rows examined, houses and outbuildings were scrutinized thoroughly, and piled cordwood and firewood inspected carefully with the result that a total of 2,695 egg clusters were found and treated; of these 650 were classified as old.

The following figures will illustrate the necessity of examining all manner of objects for egg clusters, as well as showing the indiscrimination displayed by the female in selecting a spot for depositing her eggs. Of the total number of egg clusters, 1,327 were found on apple, maple, plum and willow trees and lilac shrubs; 1,203 in stone walls, 54 being on one stone; on the outside of houses and outbuildings, 141 clusters were treated, 40 being found inside a waggon shed, and 24 on miscellaneous objects.

Work at the infestation was started again on April 15th, 1925, and further scouting was done, as the outbreak occurred on a farmer's milk route, and the milk collection was on a co-operative basis, *i.e.*, the farmers took turns to collect the milk and transport it to the creamery, the premises of each farmer on the entire route were thoroughly examined owing to the possibility of caterpillars being carried in the milk waggons, in view of the fact that a number of egg clusters had been found on the milk stand on the Guay property. In addition, as an egg cluster was found on the school house property adjacent to the infestation, the house, outbuildings and orchards of each child who attended the school were inspected. Further inspections were carried on at the outbreak itself, with the result that 150 more egg clusters were found, making a total of 2,845.

With the advent of warm weather and the approach of the egg hatching period, the banding of the 1,200 trees in the infestation commenced. The United States Bureau of Entomology kindly supplied five drums of specially prepared tree banding material, known as raupenleim. This was placed in inch wide bands around the trees, for the purpose of preventing any caterpillars hatching from eggs fallen to the ground or laid on leaves, sticks, etc., from gaining access to the foliage of the trees. Above the raupenleim bands were placed bands of burlap, under which caterpillars could crawl either for protection to cast their skins or escape the brilliant sunlight. These bands were turned at frequent intervals after the larvae had attained sufficient size. Thirteen hundred yards of burlap were used in the banding.

When hatching commenced, and owing to the number of egg clusters found, 600 yards of stone walls were burnt with a kerosene-burning outfit, which consisted of an ordinary barrel pump with a ten-foot extension rod and disc nozzle. This operation was repeated three times, 200 gallons of kerosene being used.

Both Federal and Provincial Governments are sincerely indebted to the United States Bureau of Entomology who, through the courtesy of Dr. A. F. Burgess, in charge of the gypsy moth work, furnished a high-power motor

truck spraying outfit, with all equipment and three men, for the spraying operations. The entire infestation covering an area of one-third of a square mile was sprayed twice. The first period was from June 23rd to 30th, and the second July 10th to 14th. An unusual amount of rain during the first period handicapped the work very greatly and as frequent showers followed the application of the spray it was considered advisable to respray the entire area a second time. A ton of arsenate of lead and a barrel of sticker was required for the eighty tanks or 32,000 gallons of spray that were applied.

After the spraying was completed, only one man was left at the infestation to attend to the burlap turning, as well as to see that the farmers did not turn their stock into pastures which contained trees or hedgerows that had been sprayed.

Early in November a crew was placed at the infestation once again for the purpose of rescouting the entire area, and up to this time (November 15th, 1925) not a single new egg cluster has been found. From the results obtained thus far the outlook appears to be most promising and it is to be hoped that the infestation may ultimately be exterminated.

Apart from the control work carried on at Henrysburg, scouting has been continued during the past season in other portions of the Province. A total of forty men have been engaged on this work, twenty-two of these men being employed by the Federal Department and eighteen by the Quebec Department of Lands and Forests. A total of 2,048 square miles have been covered by the various crews thus far. Owing to the danger of other isolated infestations being started due to the influx of tourists and summer visitors from the infested areas in the New England States, a special highway crew was formed, which has covered this past summer 650 miles of highway, and includes all the main highways entering Quebec from the adjoining New England States and centering on Montreal and Quebec City. It is gratifying to report at this time that no other sign of this serious pest has been found, and it is to be hoped that the invasion of this most unwelcome guest has been checked.

It will be necessary to continue this work for some years, first to eradicate the present outbreak if possible and second to scout in territory that has not yet been examined in order to assure ourselves that no further infestations occur.

THE BIRCH LEAF SKELETONIZER

Buccalatrix canadensisella Chamb.

C. B. Hutchings, Entomological Branch, Ottawa

Buccalatrix canadensisella Chamb., the birch leaf skeletonizer, is a common defoliator of the birch, and is widely distributed over the whole of Eastern Canada, the New England States and the State of New York. All varieties of this tree suffer more or less each season from the attack of this insect, a decided preference being shown for the paper birch and the yellow birch. These infestations coming as they do towards the end of the summer when the foliage is beginning to fade and consequently not so readily detected, though sometimes of a light character, do occasionally assume the form of a general epidemic. Such an outbreak occurred in 1921. Many reports were received from different parts of the Province of Ontario, as far west as Fort William, and also from the Province of Quebec, telling of the widespread defoliation by these small caterpillars.

In the Ottawa Valley the trouble was first noticed early in August, but showed no indication at that time of becoming serious. However, toward the end of that month the insect had increased in such numbers that every leaf practically seemed to be attacked. The majority of the trees appeared as if badly scorched and were objects which readily attracted the attention of even the most casual observer.

As to past epidemics, records state that from 1886 to 1891 this insect was abundant in New York State. Between the years 1890–1892, Eastern Canada and Massachusetts State suffered from its attack, while in 1892 observations made by the late Dr. James Fletcher show that the birches around Ottawa were seriously defoliated by it. In 1901 New York State again reported the skeletonizer in abundance, and in 1907 Staten Island had an outbreak. Three years later, 1910, the whole of the eastern United States was subjected to an attack by this pest which was styled as being the worst in sixteen years. The last very severe outbreak occurred in 1921, as stated in a previous paragraph, and this practically affected the birches of the whole of eastern America.

The *adult* is a very small moth of a bright brown colour with a wing expanse of three-eighths of an inch. Emergence takes place the first part of July and is continued until about the middle of the month. Our records show from July 6th to 14th as the principal dates, although an adult was observed occasionally until about the 25th.

The *egg* is laid on the underside of the leaf close to one of the veins. It is oval in outline, flat, and about .5 millimetres across. Incubation occupies on an average of two weeks, and on hatching the larva mines into the leaf.

The *larva*, a pale green caterpillar of about one millimetre in length, clears a small circular area between the two epidermal layers and its tunnel. As it proceeds the larva fills the space behind it with excrement pellets, leaving an outline much the shape of a question mark which can be clearly seen through the leaf surface. The time occupied in excavating averaged seven to eight days. The caterpillar then makes a round opening and comes to the surface where it prepares to moult. A location near the intersection of two veins is usually chosen. Here it spins an oval mat of white silk, a pseudo cocoon, or cocoonette, the outer edges being securely fastened all around. It then cuts a circular hole in the mat, crawls beneath and closes the entrance by weaving strands of silk across. Normally, the larva takes but twenty-four hours to complete this part of its life-history, but it was found that marked changes in temperature considerably influenced the work and that a cool spell would prolong this operation to three days. It then sheds its skin, leaving its covering by breaking through at a point on the outer edge, and returns to the open leaf surface where it feeds for three days. A second moulting cocoon is constructed much in the same way as the first, except perhaps it is larger and thinner in texture, and the insect is more apparent within as it lies in a horse-shoe-curved position. In another twenty-four hours it moults and comes again to the exterior to feed for three and a half to four days. The caterpillar, now full grown, measures about six millimetres in length, is slender in form and greenish-yellow in colour. Ordinarily, it moves about in a slow and quiet manner, but if in any way disturbed will become agitated and quickly wriggle off the leaf, suspending itself in the air by an invisible silk thread. In the late summer just prior to pupating, hundreds of these caterpillars can be seen hanging from the branches being blown about by the wind from place to place. Eventually, the larva drops to the ground and spins the hibernating cocoon on or under a leaf, or some other suitable material.

The true cocoon is made of white silk which later becomes greyish-brown

in colour due to the darkening of the pupal case within. It is boat-shaped in outline, with six longitudinal, somewhat parallel, ridges running the entire length, with flat base and rounded ends. In constructing this the larva first lays down a silken mat, then beginning at one end it builds up the main ridges, filling in the space between these with fine netting. As the work progresses, the caterpillar backs outwards gradually, until the structure is about two-thirds completed. It then reverses its position and begins working on the other end in like manner until it joins the two parts together and in doing this causes a slight depression, or concavity, to form at the junction, thus shutting itself in entirely from the outside. The winter is spent in this way and emergence takes place the following summer early in July.

Ornamental birches and lawn trees can be easily protected from this pest by applying an arsenical spray of one part lead arsenate to forty gallons water. This should be put on when the mines are first beginning to show about the middle of August. Nicotine sulphate, one-and-one-half teaspoonfuls to each gallon water can also be recommended.

A PRELIMINARY ANNOUNCEMENT ON THE OUTBREAK OF THE EUROPEAN PINE SHOOT MOTH

L. S. McLaine, Division of Foreign Pests Suppression, Entomological Branch, Ottawa

It has been repeatedly said that a year does not go by without the discovery of at least one new pest of major importance. It is unfortunate that the present year is no exception to this statement. Early in the spring, Mr. P. C. Brown found some larvae affecting pine buds on a shipment of nursery stock from Holland, and consigned to a firm in Windsor, Ont. The larvae and twigs were sent in to headquarters for examination and the pines placed under quarantine. The material was later sent to Mr. J. J. De Gryse, then at Indian Head, Sask., who identified the insects as the European pine shoot moth, *Rhyacionia* (*Evetria*) *buoliana* Schiff. The infested pines were burnt and the incident was regarded as closed. In fact it was thought to be the happy ending of what might have proved to be a tragic story, as the European pine shoot moth is one of the most serious enemies of pines, affecting all species and particularly injurious to those under fifteen years of age.

According to Busck, it was first found in the United States in 1914 on Long Island, New York. Subsequent investigation "established the fact that the species has been repeatedly introduced on European nursery stock, and that it has become established in nurseries and parks in several localities over nine states" (1915).

The second chapter in the history of this insect, in so far as Canada is concerned, was opened by the receipt of a communication from the Superintendent of Prospect Cemetery, Toronto, Ont., dated June 24th, 1925, in which he referred to twig injury on some young pines imported from Holland a year or two ago. Material for examination was also submitted. The larvae were identified as the European pine shoot moth, and an officer was at once detailed to investigate the situation. Upon receipt of his report, which indicated that the pest was not confined to a few pines but had spread throughout the cemetery, and was also present in other sections of the city, a scouting party was immediately

transferred to the Toronto district to make a survey of the situation. It was most unfortunate that the report of the infestation was received so late in the season as scouting could only be continued for ten days, as the insect was in the pupal stage and with the advent of warm weather the moths emerged rapidly. During this brief scouting period the insect was found at eight different points within the Toronto city limits, in parks, cemeteries, and on private grounds.

Acting on this information a circular was prepared and issued to all inspectors requesting them to reinspect all pines imported into their district within the past two years, with the result that infestations have been found in a number of nurseries, as well as on private grounds. The points at which infestations have been found to date (October, 1925) are Toronto, Bowmanville, Fonthill, Ridgeville, Guelph, St. Catharines, all in Ontario, and Victoria, B.C.

With this information at hand, it was decided to endeavour to reinspect on a systematic basis all pines imported in recent years, and as an aid in securing the required information the value of the permit system was fully established, as it was possible to trace the origin and destination of all pines imported since it went into effect. From September 1st, 1923, to June 30th, 1925, ninety-four shipments, totalling 38,756 pines, were imported from foreign countries. The information was then distributed to the inspectors in the various districts. In the case of consignments forwarded to outlying points, and where no inspectors were available, the importer was communicated with direct, the situation explained, and his co-operation solicited.

What the outcome of this work will be, it is impossible to say, but it is hoped that it will at least reveal the distribution of the European pine shoot moth in Canada, and the possibility of instituting extermination measures can then be considered.

The European pine shoot moth is undoubtedly one of the most serious enemies of pines and its invasion of the young forest plantings would be a serious blow to reforestation. The pest has undoubtedly been imported from Europe, but in one case at least there is a strong suspicion that they may have been brought in from the United States.

Let us hope that our story may have a happy ending after all, and that it will be possible to eradicate the pest before it obtains a foothold, and that it will not be necessary to add to the already too long list of injurious insects another with the footnote "of foreign origin but established and distributed throughout Canada."

MORTALITY OF THE EUROPEAN CORN BORER (*Pyrausta nubilalis* Hubn.) ADULTS AND LARVAE

L. Caesar, Agricultural College, Guelph

The data upon which this paper is based were obtained in the county of Elgin, where almost all our investigation work on the European corn borer was carried out.

In Elgin in 1924 there was a most alarming increase in the number of borers over that of 1923. More than forty per cent. of all the corn plants were attacked and in almost every locality fields could be found easily in which ninety per cent. to 100 per cent. of the plants were infested. Had the same rate of increase continued during 1925 there is not the least doubt that the corn crop of the county

---

"The European Pine Shoot Moth," August Busck, Bull. No. 170, U.S. Dept. of Agr., February 9th, 1915.

would have been largely ruined. However, the increase did not continue but instead there was actually a decided decrease. I saw no field in Elgin this fall so severely infested that it was ruined or even nearly ruined and only a very rare field which had an infestation as high as ninety per cent. The question therefore naturally arises—What caused the decrease in 1925?

Let me say first that it was not due to any abnormal winter mortality of the larvae, for this was not high; no higher than usual, so far as we could tell. Nor was it due to better clean-up measures and better plowing on the part of the farmers, because we made a study of this matter and found that on the whole no better work had been done than in the previous year, largely because the drought of the preceding autumn had made good plowing and thorough burying of stubble and debris almost impossible. Moreover, it was not due to the destruction in any way of larvae in the spring or of the pupae, for there were, we estimated, fully three times as many larvae which survived in unburied stubble and other corn remnants this spring as in that of 1924 and these practically all pupated and produced moths.

There is no doubt in my mind that the decrease was due to the difference of the weather conditions which prevailed in 1925 compared with 1924. The reduction took place between the time when the moths emerged and the larvae were not more than half grown.

There are three main ways in which it may have been brought about:

1. The weather may have been unfavourable for the moths and so shortened their lives that they did not lay nearly so many eggs as in 1924.
2. It may have had an effect directly or indirectly upon the eggs which prevented many of them from hatching.
3. It may have been so unfavourable to the young larvae as to cause an abnormally large mortality of them.

Let us now consider these three possibilities.

Having suspected in 1924 that the moths may have found weather conditions that season more favourable than usual and therefore laid more than the normal number of eggs, I decided to make an attempt this year to discover the effect of moisture, temperature and light upon the moths. Accordingly six cages seven feet high, six feet wide and six feet long, covered with mosquito netting, were placed over corn plants in the open. The first cage was left just as it was without any shade or water. The second was sprinkled with water every evening. The third was shaded by day and night to prevent radiation and dew, and received no water. The fourth was open to the sun by day but covered with oilcloth in the evening and night to prevent dew. The fifth was shaded day and night and in addition sprinkled every evening. The sixth was shaded day and night and had a constant supply of moisture and was approximately two degrees Fahrenheit lower in temperature than the others. This was brought about by a home-made refrigerator consisting of a bucket of water on a stand in the centre, about five feet high. From the bucket a cylinder of cotton with its top immersed in the water hung down to near the ground. The evaporation which took place resulted in lowering the temperature. Into each cage four female and four male moths were placed and when all these were dead a new supply was added.

Though some very suggestive data were obtained from the above cages yet so many unexpected difficulties arose, largely owing to lack of previous experience of a similar nature that it might be misleading to give in full the results. The main things shown were:

1. That moths without any moisture, even dew (there was scarcely any rain during the experiments), died in a few days, usually less than four, and laid only a small number of eggs, the average being forty-one per female.

2. That when supplied once a day with water either by dew or by sprinkling they lived at least fifty per cent. longer and laid approximately three times as many eggs, the average per female being one hundred and forty-two.

3. That where there was a constant supply of moisture and a slightly lower temperature the moths lived nearly three times as long as where there was no moisture and nearly twice as long as where moisture was supplied twice a day and there was no lowering of temperature. Moreover, they laid an average of five hundred and sixty-three eggs per female which was ten times as many as where there was no moisture and almost four times as many as where the moisture was supplied once a day and the temperature was not lowered.

It is not wise to place too great a reliance upon these experiments. We hope to repeat them next year and to eliminate mistakes. But faulty and crude as they were they clearly indicated that the difference of weather one year from another has an effect upon the moths themselves which will partly explain the fluctuation in the number of borers from year to year.

Passing on to the eggs all I shall say about these is that we noticed a much greater tendency this year for egg masses to peel off the leaf before hatching than in the previous year and also a larger percentage of parasitism. However, as no definite figures were obtained on the percentage thus destroyed, we shall for the sake of simplicity do as we did last year, namely, class all eggs as potential larvae and consider their mortality as larval mortality.

Last year in a paper read before this society* I gave the results of a study of larval mortality in 1924 in which 8,100 eggs were involved. This showed that 77.7 per cent. of the larvae perished and that their death took place during the early instars. This year an experiment similar in every respect, except that 3,900 eggs were involved, was conducted. The following table gives a condensed summary of the results:

TABLE SHOWING THE MORTALITY OF LARVAE FROM EGGS ARTIFICIALLY PLACED ON CORN PLANTS WHICH WERE KEPT FREE FROM ALL OTHER EGGS

Date eggs placed on the plants	No. of eggs used in each series	Date plants dissected and larvae present counted	No. of living larvae present	Percentage mortality
July 13	900	July 30 and 31	87	90.4
July 18	900	August 3	31	96.6
July 22	900	August 6	60	93.3
July 28 and 29	600	August 12	34	94.3
July 28 and 29	600	August 27	39	93.5
Total	3,900	Total	251	Av. 93.6

In addition to the above experiment a number of moths were enclosed in a cage over a hill of corn and after two days the cage removed and all the eggs that were exposed to the sun destroyed and those laid in normal positions counted

*Report of Entomological Society of Ontario for 1914, pp. 50-52.

and their position marked. Any eggs laid later were destroyed. From 383 eggs thus deposited only eight larvae survived at the end of fifteen days, thus giving a mortality of 97.9 per cent.

From the above experiments which, with the exception of the last, were as nearly as possible parallel to those of last year, we see that there was a much greater mortality of larvae this year than last. How great the difference was can perhaps be grasped more readily by stating that from every one hundred eggs laid in 1924 there survived at the end of a month 22.3 larvae, while in 1925 there survived only 6.4 larvae or less than one-third as many as last year.

Perhaps it will be said that the mortality in the experiment was greater than actually took place in the field. Possibly so, but that should apply to one year as well as the other and should not interfere with the proportions. In any case it is quite evident that there is a very large mortality of larvae every year and that it is not only a great factor in making control by artificial means possible but also helps to a large extent to explain the fluctuation in the number of borers from year to year. It need scarcely be mentioned, of course, that had the farmers in Elgin not ensiled or fed most of the corn and plowed under the stubble and debris no natural control factors at present active would have prevented an increase even in Elgin this year.

The question still remains—What were the underlying influences or factors which lead to the greater mortality of the larvae this year? I cannot answer definitely but think they were the higher temperature and lower moisture of this season, especially in July when egg-laying and hatching chiefly took place, compared with last season, and the consequent greater evaporation which took place. How great the evaporation was only those can realize who saw how corn oats, hay and other crops in Elgin and parts of Middlesex, Oxford and Norfolk began to wilt in July and would have been almost ruined had rain held off a week longer. It is to be hoped that the environmental factors influencing the borer may have more attention paid to them in the future than in the past. We believe that the time thus spent would be of great benefit to the entomologists most interested in combating the borer.

THE SPREAD AND DEGREE OF INFESTATION OF THE EUROPEAN CORN BORER IN 1925

W. N. Keenan, Division of Foreign Pests Suppression, Entomological Branch, Department of Agriculture, Ottawa

The European corn borer has increased its reputation as a serious pest as a result of conditions occurring in 1925. The only adjoining territory where important spread could occur is the area north and east of Toronto, and the season's scouting resulted in the discovery of infestations in twenty-five additional townships in that area. With the exception of a limited area in Elgin county, the degree of infestation has increased in the older infested areas as compared with 1924; in some sections alarmingly, while in others only slightly.

To review briefly the history of the corn borer in Ontario, it may be stated that it was officially discovered in 1920 and the infested area comprised the counties of Welland, Elgin, Middlesex and parts of Oxford, Huron and Kent. However, investigations indicated that it had been present in the St. Thomas district (Elgin county) for the previous ten years. Each season scouting opera-

tions have been carried on to determine the annual spread, and all additional townships found infested were placed under quarantine, as well as several intervening townships, for convenience in quarantine enforcement. The original area infested in 1920 covered 2,780 square miles, and by 1925 the area under quarantine had increased to 18,590 square miles, covering 227 townships, and included all territory in the southern part of the province south and west of Grey, Dufferin and Peel counties inclusive, four townships in southern York county and all shore townships, eastward along the lake to Murray township, Northumberland county, and Prince Edward county.

The scouting carried on in August and September of this year showed a further spread of the pest. The Lake Simcoe area north of Toronto, where corn is an important crop, has been examined annually since 1922 without discoveries, but this season eleven townships west of the lake and adjoining it were found infested. The territory north of the previously infested townships on the north shore of Lake Ontario were examined without results but the eastward spread along the shores of the lake and the St. Lawrence River has continued. The newly infested area on the east comprises the shore townships in Hastings, Addington and Frontenac counties (including Wolfe Island) and the townships of Escott, Yonge and Elizabethtown in Leeds county, the most eastern record being taken near Brockville. The newly infested areas comprise 1,789 square miles.

Degrees of Infestation in Infested Territory

The records of the degree of infestation in the most important sections of the older infested areas, first undertaken systematically in 1923, were continued in 1925. These have been very interesting and have been of great value from many viewpoints. Records were taken again from all points used the previous season which includes all counties bordering Lake Erie, the counties of Lincoln, Oxford, Middlesex, Huron and Lambton, and a series of points located in three circles radiating from the Union district south of St. Thomas.

Area	Highest per cent. Infestation			Lowest per cent. Infestation			Average per cent. Infestation			Total No. Fields Examined		
	1923	1924	1925	1923	1924	1925	1923	1924	1925	1923	1924	1925
Circle No. 1 (6-8 miles)	68.0	99.0	83.0	4.33	4.6	6.0	30.16	59.72	40.88	55	55	40
Circle No. 2 (15 miles)	47.0	72.0	77.0	0.0	3.6	0.3	16.97	32.52	32.15	80	80	65
Circle No. 3 (30 miles)	7.66	28.3	65.33	0.0	0.0	0.0	1.93	7.72	11.09	135	135	135
Essex Co. (80-110 miles)	13.66	82.33	100.00	0.0	0.7	0.0	1.31	13.53	37.52	48	85	85
Haldimand	.....	2.6	8.00	.....	0.01	0.0	.....	1.14	2.96	.....	10	10
Huron (50-70 miles)	1.4	3.0	9.0	0.0	0.0	0.66	0.3	1.36	4.89	12	10	10
Kent	.....	84.3	100.00	.....	0.3	4.0	.....	24.19	52.84	.....	40	40
Lambton	.....	11.3	14.33	.....	0.1	0.0	.....	3.21	5.20	.....	25	25
Lincoln	0.6	1.6	7.33	0.0	0.0	0.0	0.2	0.4	1.16	15	15	15
Norfolk, East (45 miles)	1.2	4.6	28.0	0.0	0.9	1.66	0.32	2.66	9.79	5	5	5
Middlesex (Northwest)	.....	13.3	7.66	.....	0.6	1.66	.....	6.46	3.59	.....	10	10
Oxford (40-45 miles)	2.8	12.6	13.0	0.0	0.0	0.0	0.93	3.61	3.68	15	15	15
Welland (95-115 miles)	4.4	11.0	36.33	0.0	0.0	0.0	1.06	2.92	11.56	45	45	45

Note.—Mileage stated represents the distance from Union Village, the original centre of the infestation. Welland County first found infested in 1920, and apparently a separate outbreak.

With the exception of the areas covered by circles 1 and 2, the records show an increase at all points. A further summary of the above comparative conditions with 1924 is as follows: Circle No. 1 decreased by 32 per cent.; circle No. 2 by about 1 per cent.; circle No. 3 increased 43 per cent.; Essex county increased 180 per cent.; Haldimand county, 160 per cent.; Huron county, 260 per cent.; Kent county, 118 per cent.; Lambton county, 62 per cent.; Lincoln county, 190 per cent.; Middlesex county, 51 per cent.; Norfolk (Simcoe district), 35 per cent.; Oxford county, approximately 2 per cent.; and Welland county, 295 per cent. increase.

It must be borne in mind that these records are taken from the five fields nearest to each definite point and as a consequence they do not indicate the highest degree of infestation which might have occurred in the township concerned, nor the lowest. They represent the average conditions.

The serious increase in Kent and Essex counties was expected, but in view of the slow progress of the pest in Welland county this year's situation there is interesting. Another point of interest is the increase which has occurred this year in Prince Edward county. It was first found infested last year and it was somewhat difficult to locate the corn borer in a township. This year the infestation was general throughout the county and the only stalk infestation records taken indicate approximately one per cent. As a further indication of the increase which occurred in the county it may be stated that school children gathered armsful of infested stalks in the vicinity of Picton as a result of a small fee paid by local canners and others interested.

The infestation records taken this season have confirmed, in practically all cases, the importance of late planting in reducing the degree of crop loss. In addition, investigations dealing with this point were carried on by Mr. George Ficht, of the Division of Field Crop and Garden Insects, in one of the most heavily infested districts located north of Wheatley. The observations referred to were made during the week ending September 15 and dealt with fields planted on May 13th, 15th, 26th and June 2nd and 4th. The June 4th field had 98 per cent. of the stalks infested and all other fields 100 per cent. However, the June plantings had less than 50 per cent. of the cobs infested and the May plantings 100 per cent. Furthermore, the number of larvae per stalk in the June plantings averaged about twelve whereas the May 26th, May 15th and May 13th plantings averaged about 23, 38 and 37 respectively. The number of larvae in each stalk is the important factor in crop losses and the above information is quoted to signify the increase of the pest which occurred in this territory in 1925. It may also be recorded here that many stalks carried as many as 100 larvae and the highest record was 117.

The corn-growing districts of Ontario are gradually becoming infested by the corn borer. It is true that the extent of spread some seasons has been somewhat greater than was anticipated, but it is felt that the quarantine regulations are solely responsible for the fact that the remainder of the corn-growing areas in the province are not yet infested. In time it will undoubtedly be distributed throughout the eastern counties of the province and southwestern Quebec will also be forced to take an interest, but each year that this condition is delayed represents incalculable financial saving to the corn-growers concerned.

RECENT DEVELOPMENTS IN THE INTRODUCTION OF PARASITES OF THE EUROPEAN CORN BORER IN ONTARIO

A. B. BAIRD, ENTOMOLOGICAL BRANCH, CHATHAM, ONT.

At the last annual meeting of the Society a paper was presented outlining the beginnings of this project, then centred at St. Thomas, Elgin county. With only a mediumly heavy infestation in this district and the majority of the corn stalks used for fodder, the obtaining of corn borers for use as host material in our laboratory breeding work was a very serious problem. Therefore when the infestation in the western counties of Kent and Essex increased so enormously last year, the opportunities presented for obtaining an abundant supply of host material, at comparatively small cost, were so obviously better than in Elgin, that the centre of our operations was transferred to Kent county and the laboratory established at Chatham in March of this year (1925).

The work has been carried on along the same lines as heretofore and without the addition of any new species. The warm early spring was very favourable both for the breeding and establishment of the parasites, but this was more than offset by the extremely unfavourable autumn. Our liberations were confined almost entirely to the heavily infested area along the Kent-Essex county line. A small colony was liberated at Chatham and one liberation was made around the old colony site at Fingal, Elgin county.

Habrobracon brevicornis Wesm. was again bred in large numbers and approximately 951,000 adults were liberated during the season, thus bringing our total liberations of this species over the two million mark. Through the kindness of the U.S. Bureau of Entomology, we received in June a small shipment of cocoons of this species collected in Hungary, from which we obtained twenty-five female flies, and our autumn liberations totalling 331,000 flies were bred from this stock. It may be of interest to mention in this connection that our previous liberations were bred from material collected in a section of Europe where there are two generations of the corn borer annually whereas this material came from a single-generation area. Adults of this species wintered successfully in caged cornstalks at Port Stanley, a number of adults emerging during the warm spell in late April of this year. We were unable to secure oviposition in the cage, however, presumably due to the unnatural conditions obtaining.

Our major efforts were directed toward the establishment of the larger parasite, *Exeristes roborator,* and a total of 36,700 adults were liberated as compared with 15,800 in 1924. More than 75 per cent. of the flies liberated were females and were practically all mated before liberation. This species gives excellent promise of becoming a valuable addition to our fauna. Females were seen at work in the cornfields on several occasions both by entomologists and interested farmers and some thirty-three individuals in the immature stages from egg to pupa were recovered incidentally in the collection of borers for our breeding work. All recoveries were in the vicinity of 1925 liberations.

The parasitism of the corn borer by native species still remains almost negligible. Most important is the common egg parasite *Trichogramma minutum,* which parasitizes a small percentage of the egg masses deposited during the latter part of the season. Some three or four dozen specimens of the Tachinid *Zenillia caesar* were reared from overwintered larvae and also a few specimens of three species of Hymenopterous parasites from full-grown larvae and pupae. The total parasitism by native species was decidedly less than one would anticipate with an insect as abundant as the corn borer was this past season.

EGG STUDIES OF THE CLOVER LEAF CURCULIO
Sitones hispidulus Fab.

H. F. Hudson

The clover leaf curculio, *Sitones hispidulus* Fab., is not an abundant insect of the clover field. It is common where mammoth clover is growing, it is fairly frequent in red clover and alfalfa fields, but I have never observed the insect or its work in fields of sweet clover. The insect hibernates as an adult for the winter, preferring to winter where clover debris is quite abundant. It would appear from spring collections in the field that winter mortality may be largely due to lack of sufficient cover for the winter. Live material in the spring has always been more difficult to secure than dead material. The colouration of the insect harmonizes so well with its surroundings that it is difficult to see, and the habit of feigning death gives them further security. Though possibly not an insect of strict economic importance, it nevertheless does a slight and general injury, the larvae feeding on the roots and rootlets, and the adults on the foliage. Early in the spring, usually about the first week of May, oviposition is under way. In the breeding cages eggs were freely laid on both sides of the leaf, on the petiole and stem, but the greater number were laid at the base of the plant. For this study some twenty pairs of beetles were used, and a total of 1,380 eggs were secured. We have the definite location of 1,353 of these, and it may be of interest to know that 67.18 per cent. were laid on the glass chimneys, 17.81 per cent. were laid on the leaves, 13.22 per cent. were laid on the soil, and 1.77 per cent. were laid on the stem or petiole.

The maximum egg production was found to be 165 eggs, and the average egg production per female from the twenty pairs, counting losses, accidental deaths, etc., was 69 eggs per female. The number of days in which eggs were laid ran from one to twenty-five, while the period of oviposition extended from one day to forty-three days. The duration of the egg stage varies with the temperature. From May 14th-20th, with 112 eggs under close observation, the maximum egg period was 35 days, minimum 27 days, and an average of 30.91 days. The temperature record for that week appears to have been mislaid. From May 21st-27th, with 36 eggs under observation, and a maximum temperature of 65 degrees, and a minimum of 31 degrees, giving an average of 47.2 degrees, the maximum egg period was 32 days, minimum 22 days, and an average of 26.63 days. From May 28th to June 3rd, with 38 eggs under observation and an average temperature of 54.8 degrees, the maximum egg period was 27 days, minimum 18 days, and an average of 22.07 days, while from June 4th-10th, with 42 eggs under observation and an average temperature of 55.8 degrees, the maximum egg period was 22 days, minimum 15 days, and an average of 18.90 days, and from June 11th-18th with 46 eggs under observation and an average temperature of 75.3 degrees, the maximum egg period was 19 days, minimum 13 days, and an average of 15.45 days.

The egg is subspherical, minute. Freshly deposited eggs are white, but in less than one hour change to a yellowish white and are glossy; in a few hours the yellow colour becomes more intense, while from the second to third day they turn jet black, the shell still maintaining its glossy appearance, but no sculpturing of the eggshell appears.

The larval stages have not been studied, as either the eggs failed to hatch or the larvae did not establish themselves. It would appear from field observation that the period from egg to adult would be about six or seven weeks.

THE STRIPED CUCUMBER BEETLE

Diabrotica vittata Fab.

JAMES MARSHALL, O.A.C., GUELPH, ONT.

A study of the life history and habits of the striped cucumber beetle, with a view to the discovery of satisfactory control measures, was begun in 1922 by the Department of Entomology of the Ontario Agricultural College, under Professor Caesar's supervision. In 1922, Mr. A. J. Graham conducted the investigation; in 1923, Mr. C. W. Smith; and in 1924 and 1925, the writer. The following account is but a summary of some of the data obtained in these years.

The beetles during these four years appeared in spring as soon as the weather had become warm and the daily maximum temperature approximated 80°F.

In 1922, they were first noted on May 11th when the noon temperature was 84°F.; in 1923, on May 28th, at 78°F.; in 1924, on June 9th, at 80°F., and in 1925 on June 1st, at 90°F. Their appearance seems to coincide fairly closely with the full bloom of most varieties of apples, or with the fall of sour cherry blossoms. At this time cucurbit seed may not have been sown, or the young plants may be barely above the ground.

Some years the beetles increase slowly in number and do not become numerous for two weeks or more after the earliest emergence. Other years they appear more rapidly and are in large numbers in a little more than a week. The total emergence, however, is not attained for at least ten days longer. In general, it may be said that total emergence takes place three to four weeks after the earliest emergence.

FOOD PLANTS.—The main food plants are all species of cultivated cucurbits, the order of preference as observed by us being squash, vegetable marrow, cucumber, cantaloupe, watermelon, pumpkin and citron. Wild cucumbers are also much fed upon. In addition, feeding takes place to some extent on the foliage of burdock, stinging nettle, pigweed, beans, peas, radish and curled dock, and on the unripe kernels and silk of corn. Beetles have been taken occasionally on the flowers of the following: chokecherry, raspberry, apple, cultivated cherry, wild aster, goldenrod and sunflower.

INJURY FROM THE ADULTS.—The main injury takes place while the plants are still young and up to the time when they begin to form runners. This is brought about by the beetles attacking the cotyledons and the young leaves. They cluster on the undersides of these and devour large areas, causing the leaves, and after, the whole plant to die. It is not uncommon some years, to have as many as fifty per cent. of the plants destroyed within twenty-four hours. After the plants have formed runners, growth is so rapid that it is very rare for any serious loss to occur. As soon as the blossoms appear, large numbers of the beetles feed on these, but we have never seen them cause much injury thereby. Damage by feeding on the fruit seems very rare in this province.

Several investigators have given satisfactory proof that the adults are largely responsible for the transmission of the serious disease known as cucurbit wilt, and also of yellows or mosaic. We attempted to bring about transmission by the usual methods. On one occasion we succeeded in transmitting the yellows, but all efforts to do so with the wilt for some unknown reason failed.

EGG-LAYING.—The eggs are yellow and laid singly, or in clusters of twenty or more either in contact with the stem of the host plant, or as far as four inches from it. They are placed under clods or refuse, in cracks in the ground, or occasionally promiscuously on the surface of the soil. In cages the laying period

commences about a week after emergence and in the field about two weeks after emergence. The egg-laying period continues until near the time of the disappearance of the overwintering generation, which occurs in August. In my cages an average number of 237 eggs was laid per female. The greatest number from a single beetle was 498, which were laid over a period of thirty days.

INCUBATION PERIOD.—The incubation period is five to fourteen days, the average for the four years being 9.8 days.

THE LARVAE AND THEIR HABITS.—The worm-like, white or yellowish larvae are about 10 m.m. in length when mature, but owing to their boring habits are seldom seen by the grower. We have time after time found them boring into the primary and secondary roots of cucurbits, and in root cages have seen them feeding on the fibrous roots. So far as we could determine they never attack any but the roots of cucurbits. In autumn they are commonly found feeding on the underside of decaying fruits. When numerous they cause serious deformities of the roots and may be instrumental in establishing rot, but as a rule they do not interfere much with the development of the plant.

In cages the minimum length of the larval stage was 19 days, the maximum 35 days, and the average 26 days. Under field conditions, where it seems impossible to determine its duration accurately, it will probably be greater.

THE PUPAL STAGE.—Pupation takes place in the soil at a depth of one to three inches and at a distance of half an inch to a foot from the feeding place of the larva. Before pupation a small earthen cell is formed. The pupa within this cell is so fragile that death usually ensues when the cell is broken. The prepupal stage is quite short but its exact length was not determined. The total length of time from the formation of the pupal cell until the emergence of the adult varies from eight to seventeen days. The earliest emergence of adults took place on July 16th, August 9th and August 6th of 1922, 1924 and 1925, respectively.

LENGTH OF THE LIFE CYCLE.—The time passed from egg-laying to adult emergence in insectary work was as follows:

Average length of egg stage	9.8 days
Average length of larval stage	26.0 days
Average length of pupal stage	12.4 days
	48.2 days

NUMBER OF GENERATIONS.—There was nothing to cause us to suspect that there was more than one generation a year.

HIBERNATION.—There has been much discussion and conjecture as to this insect's mode of wintering. Our endeavours to find it in winter quarters were for three years fruitless, despite the fact that diggings and careful observations were made in all situations in which it was felt that there was even a remote possibility of its being found. On November 6th of this year, however, we found adults hibernating practically on the surface of the soil, but covered with a dense mat of withered grass some three inches thick. In such surroundings it is extremely difficult to see them, which may in part explain our previous failures. It is thought by some that the insect may winter also in the pupal stage. Only two pupae were uncovered on November 3rd of this year after several hours of digging in our cucurbit plots, whereas in the early autumn, dozens of them could be unearthed in a single hour. When, in addition to this, it is considered that we have never unearthed a pupa in spring, even in fields heavily infested the previous year, it would seem obvious that with us hibernation occurs exclusively or practically so, in the adult stage.

During the winter of 1924-25 Professor Caesar sent out a questionnaire relative to the hibernation of this beetle to most of the prominent economic entomologists of North America. He received forty replies of which thirty-five indicated that the writers had no definite information on the subject. Of the remaining five, Professor Crosby and Dr. Huckett of Cornell University had each found beetles in woods under shelter of leaves. Mr. J. E. Graf of the United States Bureau of Entomology stated that the late H. O. Marsh found adult beetles wintering under rubbish and leaves in berry patches at Rocky Ford, Colorado. Mr. Graf himself had obtained about ten per cent. spring emergence by caging adults over tightly packed weeds and leaves in the autumn. Mr. J. S. Houser of the Ohio Agricultural Experiment Station carried some beetles through the winter in cages, and Dr. W. V. Balduf of the University of Illinois reported finding beetles near and under old squash plants in November and again in January.

Control Measures

Any cultural methods which will produce a speedy growth in young cucurbit plants are helpful means of lessening serious injury from this insect; dusting with chemicals, however, provides the most effective means of control. In our experiments a total of over sixty dusts, sprays, fumigants and baits were tested, but of this number only the most effective four substances will be discussed here. These substances are all dusts.

1. Two per cent. nicotine dust, the nicotine being 100 per cent. free nicotine.
2. Wisconsin dust, composed of eight per cent. black leaf "40", twenty-five per cent. anhydrous copper sulphate, sixty-seven per cent. hydrated lime.
3. Arsenate of lime and gypsum (the well known Ohio dust) one part to twenty parts by weight, not by measure.
4. Sodium fluosilicate and hydrated lime, one part to nine parts by volume, not by weight.

Both of the nicotine dusts are strongly recommended in some sections of the United States, but under our conditions they are not satisfactory. This is largely owing to the fact that several applications of any dust must be given, and this makes them too expensive, especially when cheaper dusts give practically as good results.

As might be expected, the free nicotine dust kills more quickly than the Wisconsin dust, but its toxic power is exhausted within twenty-four hours and the resultant lime residue is not a very good repellent. The toxic effects of Wisconsin dust are more prolonged, so that it probably ultimately kills as many beetles. It has the added advantage of being a good repellent as long as it remains in quantity on the vines. Both of these dusts have pungent fumes, but those of the Wisconsin dust are much the more objectionable, and make its application difficult and very offensive to the operator, unless wind conditions are favourable. Wisconsin dust costs $17.00 per one hundred pounds F.O.B. Burlington, Ontario, and Free Nicotine dust $16.75 per one hundred pounds F.O.B. Louisville, Ky.

The third and fourth of the dusts listed may now be considered. They were both applied as were the nicotine dusts (a) in cages where mortality counts were made, (b) in the field by means of a hand duster, Niagara make. They appear practically equally toxic, and although neither of them gives absolute kills, dead beetles are quite common in treated fields, especially so in those treated with the sodium fluosilicate dust. The cage experiments showed that

when all of the plant surfaces were dusted a sixty-two per cent. kill was obtained with the arsenate-gypsum dust, and a sixty-six per cent. kill with the sodium fluosilicate-hydrated lime dust. When only half of the plants were dusted the arsenate dust killed forty-two per cent. and the fluosilicate thirty-five per cent. This indicates that the entire plant need not be covered, nor the beetles themselves dusted, in order that considerable mortality may follow. In this connection these mixtures are superior to the nicotine dusts. Aside from their toxic properties they are, with the exception of Wisconsin dust, the best repellents that we have tested. The arsenate-gypsum dust is slightly superior to the fluosilicate-hydrated lime dust in this respect. Bearing in mind the fact that it does not produce 100 per cent. mortality, the weakness of the arsenate-gypsum dust lies in its tendency to clog the duster in damp weather, and in the fact that it is not quite as good a spreader as the fluosilicate-lime combination. The latter dust is the easiest of application of all those used, as the hydrated lime diluent acts as a good spreader and dusts well under damp conditions, and the sodium fluosilicate while toxic to various insects is practically harmless to the operator. As the insecticidal value of sodium fluosilicate is but a recent discovery, our experiments with it have only extended over the past season. Four applications at the dilution previously indicated produced no evident stunting or burning of cucurbit plants.

The cost of application of these two dusts is practically the same, being about ninety cents per application per acre, labour included. Four or five treatments would be necessary each year, making the average yearly cost \$3.60 to \$4.50 per acre.

Sodium fluosilicate is a promising insecticide, and if, as we expect, it can be procured in a more finely ground condition, it may prove to be the most valuable substance to use in combating the striped cucumber beetle. In the meantime it would be advisable to use the arsenate of lime-gypsum dust, one part to twenty parts by weight.

GARDEN INSECTS OF 1925 IN MONTREAL DISTRICT

LIONEL DAVIAULT, MACDONALD COLLEGE, P.Q.

The last season was not characterized by any bad outbreaks of insects. Each year the same insects are found doing practically the same amount of damage.

Snails did considerable injury to lettuce, in hot houses, in the spring.

Cut-worms were in large numbers this year, especially in tobacco regions. The best method found for controlling them was to spread poison bran by hand two days before planting and to repeat it two days after.

Wire-worms were abundant in fields of grain following a clean culture. At St. Angele (Nicolet) we counted fifteen worms per square foot of soil.

Grasshoppers were found very injurious this year to celery crops, especially around St. Vincent de Paul.

The onion maggot (*Phorbia cepetorum* Meade) and the cabbage root maggot (*Pegomyia brassicae* Bouché) were as serious enemies of garden plants as ever. Many gardeners have abandoned the growing of onions because of the losses due to the onion maggot, and many others will discontinue this culture unless some good treatment is found.

The corn root maggot (*Pegomyia fuscipes* Zett.) caused many farmers to resow their corn this spring. This occurs generally on soil too heavily manured in the spring.

In certain cases the potato flea beetle (*Epitrix cucumeris* Harr.) reduced considerably the foliage of the potatoes but the crop seemed not to be affected proportionately.

The tarnished plant bug (*Lygus pratensis* L.) and the thrips were very bad pests of the chrysanthemum. The first insect attacks the flower's buds and the second feeds on the leaves.

In July we found many fields of peas, around Chambly Basin, entirely covered by large green aphids (*Macrosiphum pisi* Kalt). We sprayed a field of twelve acres with nicotine sulphate and as a result all the aphids died and the crop was saved.

Leafhoppers

For many years the Provincial Entomologist has received complaints about leafhoppers which were supposed to cause lot of damages to the celery crops. Last spring I was instructed to investigate the problem in order to find a means of control.

It was not late in the season before I recognized that the rust of celery instead of the insect was responsible for the losses which the celery grower suffers each year. But I remarked also that if the leafhoppers were of little importance to the celery growers they were very bad pests of the lettuce and spinach.

In the following lines I shall give a brief résumé of last summer's work without drawing any definite conclusions because it is inadvisable to do so after only one year research.

Classification and Localities Affected.—The leafhoppers were common on the garden plants throughout the season. They were found by hundreds on mucky soils containing a large amount of clay, and in boggy places.

The species more commonly found were *Cicadula sex-notata* Fall, *Helochara communis* Fitch, *Empoasca mali* Le Baron and *Parabolocratus viridis* Uhler.

The localities of St. Michel, St. Hubert, Ste. Rose and St. Vincent de Paul were the ones which were affected around Montreal. *Helochara communis* is especially found at St. Hubert and St. Michel because large quantities of swamp lands may be found there. *Cicadula sex-notata* is probably the most important because it is not limited to any kind of soil and is of great abundance.

Nature of Injury and Plants Affected.—The leafhoppers injure the plants in making thousands of little punctures with their pointed beaks which serve for the extraction of the sap.

These feeding punctures were followed by spots in plants like oats and celery, but in potatoes, lettuce and spinach the effect was more generalized, and it affected the whole leaves. A leaf of lettuce badly affected becomes wilted and then changes to brown, having about the same appearance as a plant affected by sunscald. About the same thing occurs also in potatoes and the phytopathologists define it as Hopperburn.

As previously stated, in the case of oats and celery there is only a spot produced. Osborn has observed the development of these spots for oats: "When first made they are whitish, then they change to yellow, then to brown, and later to black, often they show a black or brown centre surrounded by a reddish or yellowish border resembling very closely a fungus spot. It is therefore difficult to separate them.

The cause of the production of these spots is unknown yet. Some claim they are due to the presence of a disease, and others, to the introduction of a poison.

Life History.—It has been difficult for me to work out the life history of these pests because it was late in the season before I recognized them. However,

I think I am right in assuming that the principal leafhoppers studied have three to four generations a year. The first one apparently occurs only on grasses which grow in the garden, the other generations are passed on the vegetable plants. The adults of the fourth generation and also the nymphs who did not have time to complete their development over-winter in sheltered places.

CONTROL.—In case of insects like the leafhoppers, only preventive methods may be recommended. Knowing that the grasses, weeds, rubbish are good shelter places for winter times, it is advisable to clean the fields of them.

Bordeaux mixture, which is used so successfully in the control of the potato leafhopper, has given here also very good results, but plants treated with it should be washed with tap water before being sent on the market. In our experiments, Bordeaux mixture was applied with a hand-sprayer, the plants being sprayed on both sides. Three to four applications were found to be required.

We have failed in all our experiments with black leaf 40. The nicotin dusts gave better results. The best one is the precipitated nicotin sulphur. This is a cheap product easily spread over the plants and very effective.

PARASITES OF WHITE GRUBS IN SOUTHERN QUEBEC A PROGRESS REPORT

C. E. PETCH AND G. H. HAMMOND, DOMINION ENTOMOLOGICAL LABORATORY, HEMMINGFORD, QUEBEC

Before proceeding with the report of the investigational work carried out this year in connection with life history studies of parasites of *Phyllophaga anxia* Lec., the only economic species of Phyllophaga in Southern Quebec, it would be advisable to outline the life history in the vicinity of Hemmingford in so far as it has been studied and is associated with the life history of the parasites.

The life cycle in this district occupies three years and the broods are very strongly differentiated, overlapping to an extent of less than one per cent. The flight year of the beetles previous to 1925 was 1922, and 1928 will unquestionably be the next one. At Hemmingford and throughout Southern Quebec generally, extending from Covey Hill to Rougemont, thence southward toward the border, the life history of *P. anxia* Lec. is essentially similar in the main details and the phases of the life history come within regular periods. The great fluctuations in the number and development of white grubs cause very marked fluctuations in the number of the principal parasites—*Microphthalma michiganensis* Tns. and *Tiphia inornata* Say.

During 1923 second year white grubs were present, especially in permanent or timothy sod, in excessive numbers and a considerable amount of damage was caused to the crops. These grubs were full grown during the late spring of 1924, when they caused a fair amount of loss to vegetation and became quiescent several weeks before pupation began. Pupation commenced on July 12th and was gradual until the termination of the period on September 1st. The pupal period averaged 44.5 days. Adult formation was general between August 17th and October 6th.

The beetles remained in the soil during the winter and began to emerge in small numbers on May 14th. The flight period lasted until June 19th,

although a few continued to fly until June 28th. Forty per cent. of the total collection made in light traps was taken during the first week in June when the temperature for the week averaged 70.8 degrees Fahrenheit. In dry weather when the temperature was over fifty degrees Fahrenheit, between eight and ten p.m., the flight was always moderately active over the main part of the flight period. Mating occurred between May 26th and June 2nd, on the favourite food plants which were, in order of importance, white elm, white oak, silver-leaved poplar (Populus alba), aspen (Populus tremuloides) and cultivated raspberry.

Eggs were found in the soil during the latter part of June and early July. The egg stage in the case of eggs collected in the field and hatched in the laboratory occupied a period of 47.3 days. Hatching of the eggs began on June 28th and continued to August 16th. The first year white grubs have a single moult during late summer and fall and thus hibernate in the second instar.

Pyrgota undata Wied.

This Ortalid adult parasite was found rather commonly during the past season but it did not occur in numbers sufficiently large to permit of a detailed study of the life history. From preliminary observations, however, it is apparent that it is not present in sufficient numbers to be included in the list of effective natural checks, since it parasitizes less than one-tenth of one per cent. of the total adult beetles in flight.

Curiously enough the first specimens of the flies were flying on June 3rd, or over three weeks after the first substantial June beetle flight. On June 8th and 9th the parasites appeared in moderate numbers and were found mating in most cases on shrubbery bordering meadows and pastures between 10 a.m. and 6 p.m. during the day and presumably during the greater part of the night because many of them were drowned after midnight in the water pans of the June beetle traps. On June 13th and 14th Pyrgota was not found so commonly through the day but seemed to be much more active during the night, when as many as twenty specimens were collected from June beetle traps. The flies were doubtless drowned when following June beetles as they flew to trap lanterns. Flight terminated on June 24th when a single specimen was seen on the wing which appeared to have emerged fairly recently, after a complete disappearance of the species since June 17th.

A total of seventy-three parasites were collected of which 31.3 per cent. were males and 68.7 per cent. were females. Flight of the adults is rapid but resembles the flight of the larger crane flies; when disturbed the flies take to the wing quickly and usually disappear through thick shrubbery to evade pursuit.

Hydrotaea houghi Mall.

The above fly was reared in small numbers from a group of dead June beetles which were exposed in pot cages for several weeks. Adults emerged from puparia on July 6th, 22nd, 25th, 27th and 31st; the species is believed to be normally saprophytic, no record of parasitism being noted.

Pelecinus polyturator Drury

On August 18th a single pupa of this species was dug out of permanent sod badly infested by white grubs. The pupa, of which a good photograph was prepared by Mr. F. C. Hennessey, is easily recognizable because of its close

resemblance in form to the adult. The entire pupa is invested by a yellow membrane which is wide and loose-fitting over the abdomen but it becomes much closer-fitting over the head and thorax. Because of the semi-transparency of the pupal membrane the segments of the abdomen may be plainly seen. The dead white grub host was found close to the pupa, flattened laterally and discoloured but with a certain amount of internal tissue which was not consumed by the parasite. The Pelecinus larva emerged from the grub through a slit which extended along the mid-ventral line of the body from the caudal extremity to the sixth abdominal segment.

Tiphia inornata Say

A series of 500 Tiphia cocoons were collected in the field during the fall of 1924 which were placed in hibernating quarters but they developed very slowly during the early spring of 1925.

When examined on May 19th, 8.8 per cent. of the total prepupae had been killed by fungi and molds and 10.8 per cent. had reached the adult stage. A few prepupae had advanced in development to the pupal stage. After this date the entire group of Tiphia material from the previous year failed to show marked signs of development during the summer although kept in soil boxes during this period under conditions as nearly natural as possible.

In September, 154 of 400 prepupae were still alive but were in a condition of dormancy. The original whitish colour of the prepupa remained as when first formed, except for a light yellowing over the extremities. As anticipated, the flight of Tiphia was large and important this season. The males appeared in large numbers on June 4th when the temperature was 75 degrees Fahrenheit, and when the June beetle flight hovered around the maximum. Tiphia adults swarmed over shrubbery and weeds along roads and fences and seemed to have a very marked preference for the terminal twigs of choke cherry (*Prunus virginiana*) as a resting site, especially where second growth foliage grew thickly to a height of from two to four feet.

There is a distinct range of flight for both males and females of Tiphia, the males appearing fully ten days prior to the main flight of the females. Between June 12th and 29th both males and females were present in fair numbers but from that date onward the number of males declined rapidly until the practical termination of their flight on July 5th. The activity of the females reached its height on July 13th, but moderate numbers were present on foliage until July 26th. Generally speaking, Tiphia adults were active throughout the flight period when the temperature during the day was above fifty-five degrees Fahrenheit but below this temperature few or no specimens appeared in exposed positions.

Very few white grubs were present in the soil over the period when Tiphia adults were active. Under such conditions a high percentage of parasitism would be expected but the reverse was true and eggs and larvae of Tiphia were rarely found on second and third year white grubs collected during July. Hence, according to expectations, few cocoons were found behind the plow during the fall of 1925, regardless of the type of culture of the soil during the past season. The flight of *Tiphia inornata* Say will therefore be slight during 1926 but as the second year white grubs will then be large enough to support the development of the ecto-parasitic larva of Tiphia there will follow an increase of the parasite with the successful pupation of a fair number of individuals. In 1927 a condition similar to that occurring in 1924 will obtain in that a moderate number

of females will oviposit on the plentiful supply of third year white grubs and during the fall of the same year there will be a large number of cocoons formed in the soil from which adults should emerge during the spring of 1928.

In captivity Tiphia adults are very sensitive to changes of temperature and humidity and it is therefore difficult to determine the egg capacity of the females. Oviposition occurred readily in rearing tins, although seldom more than one or two eggs were deposited by one individual.

Eggs were deposited in the folds of the anterior thoracic segments on either side of the median line. Oviposition usually commences on the most anterior fold of the dorsum and progresses caudad over the succeeding sutures when several eggs are laid. Oviposition or sting scars similar to those found on the ventral side of eggs occur among the eggs but in an indefinite arrangement. Presumably the Tiphia female stung the grub in order to quiet it but failed to deposit the egg. Another explanation for the scars would be that the female stings the very restless grubs twice, on separate spots, in order to quiet them. It seldom happened that either eggs or sting scars followed in succession to the first abdominal segment.

Many eggs were crushed through the contortions of the grubs. In a series of 180 eggs, 28.3 per cent. hatched, 30.5 per cent. failed to hatch and 31.1 per cent. were crushed. Oviposition in the laboratory was common between July 3rd and 20th and the eggs hatched between July 16th and August 10th. Cocoon construction occurred mainly between August 15th and September 10th. The egg period averaged 15.4 days, the larval period 30 days and the combined egg and larval periods averaged 45.4 days.

Larval growth is very slow during the first ten days, becoming more rapid toward the termination of the twenty-day period and during the eight-day period preceding cocoon construction growth is very rapid. The Tiphia larvae leave the fixed position on the host at the commencement of the last growth period and feed through an enlarged opening in the cuticle of the host upon the internal organs.

The following table gives the growth measurements of individual Tiphia larvae in millimetres:

Tiphia inornata Say Larval Growth Measurements

Tiphia No.	DS 3	GA 7–1	GA10–1	GA 23	GA 30	GA 31	GB 11
Date Hatched	26 VII.	25 VII.	18 VII.	16 VII.	19 VII.	18 VII.	22 VII.
Date of Measurement							
18 VII	....	....	1.2	....	....	1.1	....
20 VII	....	....	1.3	....	1.3	....	....
22 VII	....	....	....	2.5	1.6	1.85	1.3
23 VII	....	....	1.9	2.6	....	2.2	1.6
25 VII	....	....	2.3	2.8	2.2	2.7	....
27 VII	1.6	....	2.35	3.0	2.7	....	1.7
28 VII	1.6	....	2.4	3.2	2.7	2.9	1.75
1 VIII	1.7	....	....	....	3.2	3.0	....
3 VIII	2.8	....	3.9	5.5	4.2	4.3	....
4 VIII	2.9	....	4.1	....	....	4.5	1.8
7 VIII	....	....	5.0	7.6	5.0	7.3	....
10 VIII	....	....	7.0	....	7.1	9.0	....
15 VIII	9.0	....	16.0	18.0	10.0	17.0	....
17 VIII	10.0	18.0	Coc. started	....	....	....	....
19 VIII	....	20.0	coc. started	....	....	....	....

Tiphia females showed a marked preference for third year white grubs on which to oviposit. Grubs infested by one or more larvae of *Microphthalma michiganensis* Tws. were always oviposited upon by Tiphia. The resulting Tiphia larvae continued to feed on the white grub host until the Microphthalma larvae emerged from the grub.

Microphthalma michiganensis Tws.

In the Annual Report of the Entomological Society of Ontario for 1924, page 25, *M. michiganensis* was referred to as a new species, which, although taken from a wide range of localities, was thought to be new. Mr. C. H. Curran has since examined the type specimens of the above and found that they agreed with the new species *M. phyllophagae* Curran, the description of which was published in "Entomological News."

In the above description the abdomen is described as being wholly pollinose when viewed from behind in the case of both *M. phyllophagae* Curran and *M. michiganensis* Tns. and the genitalia is very similar but the claspers are less narrowed and not acute at the apex, while the forceps are a little more concave behind the smooth surface. The above differences may be associated with local races if they are consistent with geographical distribution.

In addition to the locality notes for *M. michiganensis* published in the Report of the Entomological Society of Ontario, 1924, page 25, may be added Abbotsford, Rougemont and St. Hilaire, Que. It was as plentiful at these places as at Hemmingford in similar sites.

Although the number of adults of the above species during 1924 was exceptionally large and of great economic significance, the flight during 1925 was slight and unimportant. While this great reduction in the number of these parasites is remarkable the cause of the fluctuation may be ascribed to the fact that during the period over which the flight of Microphthalma extended the large series of third year white grubs had either pupated or developed into adults. Such being the case, the only suitable hosts for the new brood of larvae were a small number of second year white grubs which were a year behind the main life cycle in development and consequently a relatively small proportion of the young Microphthalma larvae were successful in finding white grub hosts.

To offset the disadvantage of a small number of available hosts, parasitism of white grubs during the spring of 1925 averaged 45.2 per cent. and the third year grubs contained an average of 1.9 parasitic maggots per grub, the actual number varying with the individual between one and five.

Pupation began June 13th this year as compared with June 6th last year, or twenty-three days earlier. It continued until August 17th, or 24 days later than in 1924, and reached its maximum on July 29th. The instances of pupation occurring from August 10th to 17th were unnatural and no adults emerged from these puparia.

It is interesting to note that Tiphia larvae consume practically all of the internal tissues of the host before constructing the cocoon but Microphthalma larvae emerge through the body wall and leave behind a considerable amount of liquefaction and internal tissue.

Adult emergence began in the laboratory on July 21st and continued until August 24th, reaching its height in the laboratory series on July 10th and in the field on July 15th. During 1924 from thirty to fifty specimens of Microphthalma could be obtained in one half hour collecting in the field but during the maximum flight of 1925 it was seldom possible to collect more than one or two flies in the same period. From the small number of parasitized second and first year grubs

obtainable during the present fall it may be safely assumed that the flight of Microphthalma during 1926 will also be small. However, unless ecological conditions are unfavourable there should be a fair increase in the species similar to that obtaining in 1924.

A limited number of Microphthalma-infested grubs were turned out behind the plow this fall but practically all of them were second year grubs and only rarely were first year grubs found to be infested.

Some interesting points relative to the structure and bionomics of the larva have been noted. Four stages have been identified from the structure of the mouth hooks and a fifth stage may exist which has not yet been isolated. The most useful guide to the identity of the larva probably is the mouth hooks, which in the mature larva each consist of two tapering, downward-directed processes. The apices of these processes are sharply pointed and are projected slightly backward and the area intervening between the two anterior hooks and the posterior pair is a smoothly-rounded arch. The dorsal side of the mouth hooks is smoothly rounded from the outer or anterior side of the frontal pair of hooks to the dorso-caudal margin. In comparison to the size of the Microphthalma larva the entire cephalo-pharyngeal skeleton is small, measuring only .75 millimetres long in the mature specimens. After entering the body of the host the young parasite constructs a respiratory funnel which invests the caudal third of the parasite and the anterior two-thirds of the body is enveloped in a cyst. The respiratory funnel becomes narrowed as it approaches the cuticle of the grub and it passes through the cuticle in the form of a slightly-tapering tube with a bluntly-rounded apex, on the upper side of which is a tiny orifice, the respiratory pore, through which air passes into the respiratory funnel to the posterior spiracles. In the last larval stage the respiratory tube disappears and by some obscure process a large opening is dissolved away in the body wall of the grub to allow the exit of the parasite which exposes the caudal extremity of the body first. The posterior spiracles undergo a considerable change in form. They are small, rounded and not highly chitinized in the first and second stages of the larva but in the third and possibly fourth stages they bear much the same form as is present in the mature larva. Each spiracle, however, possesses, in addition to the three almost parallel slits, a single rounded opening on the upper side of the central slit, bordered on either side by the outer slits.

The anterior spiracles are separate in the first two larval stages but these later unite to form a single organ with approximately nineteen tiny openings over the outer bifid area.

Asilus snowi Hine.

A series of 259 Asilid larvae which were collected behind the plow during the fall of 1924 were placed in rearing tins and covered with one foot of soil. In May, 1925, thirty-seven of the above total were alive and the remainder were mostly killed by winter temperatures, while all the white grubs placed in the tins for food were dead. Some of the tins containing Asilid larvae were not supplied with food in the form of fresh white grubs and from these tins larvae pupated as readily as from the tins which contained food for the Asilid larvae. Hence it is assumed that the larvae of *Asilus snowi* Hine. does not necessarily require food in the early part of the third year larval period in order to successfully pass through the pupal stage. Two larvae were parasitized by Hymenopterous insects but neither species transformed into adults. The larvae which survived pupated over the following periods given in tabular form below:

No. larva	Date pupation	Date emergence	Pupal period
173	13 VI.	21 VII.	37 days
121	13 VI.	20 VII.	36 "
60	13 VI.	20 VII.	36 "
63	13 VI.	21 VII.	37 "
177	13 VI.	22 VII.	38 "
135	13 VI.	18 VII.	34 "
141	13 VI.	19 VII.	35 "
170	13 VI.	9 VII.	25 "
122	13 VI.	29 VII.	45 "
146	14 VI.	22 VII.	37 "
7	15 VI.	25 VII.	41 "
59	22 VI.	27 VII.	35 "
1000-8	13 VII.	14 VIII.	32 "

Average pupal period, *36.0 days*.

The pupa of *Asilus snowi* is ordinarily light brown in colour, 15 millimetres long, with a row of stout, short spinulae around the posterior margin of each abdominal segment. The caudal extremity of the pupa is armed with two medium sized spinulae. The head bears a large, sharply-pointed spinula on either side of the mid-frontal line, while along the lateral area of the head are a series of three shorter spinulae attached together at the base. The pupa is capable of considerable motion in a spiral form and the abdominal spinulae aid in lifting the pupa upward through the soil. Previous to emergence the pupa becomes dull grey and the adult issues through a split which extends along the mid-dorsal line of the thorax from the caudal area of the head to the anterior margin of the first abdominal segment.

In 1925 the adults were present in much greater numbers than during the two previous years and among the white grub parasites and predators the above species ranked next to *Tiphia inornata* Say in numerical importance. Robber flies, of which *A. snowi* composed 98 per cent. during the season, destroyed a large number of noxious Diptera and Lepidoptera. The cherry-tree ugly nest moth, *Cacoecia cerasivorana* Fitch, was very common in local areas and the above species of robber-fly was noted feeding on the moths daily.

On account of their small size few Asilid larvae were found in soil infested by white grubs but like the second year white grubs their presence will be much more apparent during 1926.

Mites

Two species of mites, *Rhizoglyphus phylloxerae* Riley and *Tyroglyphus armipes* Bks. were both common and prevalent on third year grubs during 1924, but during the present season they were uncommon, rarely being found on first year grubs and not nearly so numerous on third year grubs.

NOTES ON THE LIFE HISTORY OF THE CLOVER ROOT BORER

Hylastinus obscurus

H. F. Hudson

The clover root borer, *Hylastinus obscurus,* is not regarded as an important clover insect, because it usually attacks plants in the second year of their growth and clover being a biennial is usually ploughed under after the second season. This may not always happen, and a field that is left for several years where volunteer clover is allowed to grow, may seriously menace a field of young seeds in the immediate vicinity, and such not infrequently happens. Where it does occur the young field is undoubtedly injured, for any insect that feeds upon the roots of the plant must check its growth. Such an injury occurred in a local field, and some observations were made on the life history of the insect. On April 27th some field collections of infested roots were made. It was found that roots that were spongy and full of water contained no beetles, though ample evidence of the work of the insects was apparent. From an examination of sixteen roots we collected two larvae, two pupae, seventy-five living adults, and four dead ones. One adult was taken on the crown of the plant, the only one seen on the outside of a root. On May 1st another field examination was made and from sixteen roots, forty-eight living adults and seven dead ones were taken. Dead beetles were frequently observed in water soaked roots, or those beginning to mould. On May 2nd, from the same number of roots, one larva, forty-seven living adults and six dead ones were taken; on May 3rd, from fifteen roots, sixty-six living adults and ten dead ones were taken; on May 4th, from sixteen roots, forty-five living adults and twelve dead ones were secured; on May 7th, from sixteen roots, three larvae, thirty-five living beetles and three dead ones were secured; on May 9th, from sixteen roots; two larvae, twenty-nine living adults and five dead ones were taken; on May 11th, from sixteen roots, two larvae, forty-two living adults and one dead one were taken; on May 15th, from sixteen roots, one larva, two pupae, thirty-four living adults and three dead ones were taken, while on May 18th from the same number of roots fifty-three live adults and four dead ones were taken.

Movement of adults to new plants was now in progress. Breeding experiments were started early in May, and the first eggs were secured May 28th. For this study some thirty-eight pairs of beetles were used, but the egg capacity of the female was not found to be very high. The largest number of eggs secured from a single female was sixteen, and the total egg quota from all egg-laying females was 152. The period of oviposition extended from one to sixty-seven days. From a close study of thirty-four eggs, the maximum length of the stage was found to be seventeen days, the minimum nine days, and the average 12.67 days. Eggs in the field are easy to find, but never more than six were ever found in one root.

The egg, length .65 millimetres, width .4 millimetres. When freshly laid the egg is smooth and moist, shining, watery white in colour. The shell is somewhat elastic. A faint tinge of yellow is noticed in a few days but there is no great change in appearance during incubation. The larval head being light in colour is not conspicuous through the shell.

Deposition. The beetles enter a plant selected for oviposition through the crown, the stem, or in the side of the root, one-half inch to one and one-half inches below the crown.

A more or less winding burrow is formed downward. At intervals along this small pockets are made nearly as deep as the length of the eggs, which are deposited therein singly, afterwards covered with frass. Two to six eggs are usually deposited in a single root. Egg laying continues throughout the summer, beetles that started to lay the latter part of May continued ovipositing up to August 3rd. The larval stages were not studied in the laboratory, we found it impossible to keep the roots fresh long enough, also that once the larvae is removed it fails to re-establish itself. However in the field we found the first pupae July 15th, so that the probable larval stage would be four or five weeks. From July 15th various field observations were made with the following results:

From 8 roots: 4 adults, 2 pupae, 45 larvae.

July 22nd from 8 roots: 1 beetle, no pupae, 32 larvae.

July 26th from 8 roots: no beetles, 1 pupa, 36 larvae.

August 3rd, first adult emerged; from 8 roots: 2 newly emerged adults, 16 pupae, 24 larvae.

August 12th from 8 roots: 3 adults, 12 pupae, 39 larvae.

More extensive field counts were made late in August, September and October.

The average infestation per plant for the month of August (from 77 plants) was: larvae, 4.09 per cent.; pupae, 2.05 per cent.; adults, 1.54 per cent.

The average infestation per plant for September (80 plants) was: larvae, 77 per cent.; pupae, 75 per cent.; adults, 1.87 per cent.

The average infestation for October (16 plants) was: larvae, 12 per cent.; pupae, .06 per cent., and adults, 4.44 per cent.

From these studies it would appear that the winter may be spent either in the adult or larval form, with a possibility that in some cases pupae may winter over. We have not located any parasites, neither have we detected any predaceous enemies.

Control. The control of the insect is simple. Ploughing under clover after the second crop is taken off, and the destruction of volunteer clover is all that is necessary.

THE ENTOMOLOGICAL RECORD, 1925

NORMAN CRIDDLE, ENTOMOLOGICAL BRANCH, DOMINION DEPARTMENT OF AGRICULTURE

In preparing the "Entomological Record" for 1925 we have followed along the lines laid down in 1924. The cost of publication has obliged us to curtail certain details and to restrict to a minimum the number of zonal records. Judging from the interest taken in this publication, however, we believe it is still a direct stimulus to research in entomology, and, as such, still worthy of continuance.

Among the works dealing with insects are a number which appear at irregular intervals and in publications little known to many of our readers. A brief summary of the more important of these is given below:

Revision of the New World Species of the Tribe Donaciini of the Coleopterous Family Chrysomelidae, by Charles Schaeffer, Brooklyn Museum Science Bulletin, Vol. 3, No. 3, 1925. This paper contains a description of every known North American species of the tribe in question and gives the distribution of each in detail. It should be in the hands of every working Coleopterist.

Contribution to a Monograph of the Syrphidae (Diptera) from North of Mexico, by C. H. Curran, Kansas University Science Bulletin, Vol. XV, No. 1, December, 1925 (dated 1924). This is an indispensable paper to students of the Syrphidae and an important contribution to a knowledge of the Canadian species, a number of which are described for the first time.

The North American Dragonflies of the Genus Somatochlora, by E. M. Walker, University of Toronto Studies, Biological Series No. 26, 1925. An important work dealing with both the adults and early stages and illustrated by numerous plates.

The American Species of the Tachinid Genus Peleteria Desv. (Diptera), by C. H. Curran.

A Preliminary Revision of Some Charopsinae, a Subfamily of Ichneumonoidea or Ichneumon-flies, by Henry L. Viereck.

The Ephemeroptera of Covey Hill, Que., by J. McDunnough.

The above three papers were published in "The Transactions of the Royal Society of Canada," Third Series, Vol. XIX, 1925.

NOTES OF CAPTURES

Species preceded by an asterisk (*) described since the last "Record" was prepared.

LEPIDOPTERA

(Arranged according to Barnes and McDunnough's "Check List of the Lepidoptera.")

Nymphalidae
286 *Junonia coenia* Hbn. Naswaaksis, N.B., (W. Kasson).

Noctuidae
1152 *Schinia trifascia* Hbn. St. Thomas, Ont., Aug., (James).
1190 *Schinia roseitincta* Harv. Aweme East, Man., June, (E. Criddle).
2466 *Acronycta elizabeta* Sm. Strathroy, Ont., (Hudson).
2803 *Amolita fessa* Grt. St. Thomas, Ont., (James).
3106 *Catocala grynea* Cram. St. Thomas, Ont., (James).
3246 *Autographa surena* Grt. Hopedale, Labr., (Perrett).
3285 *Abrostola formosa* Grt. Victoria Beach, Man., (C. W. Gowan).

Geometridae

3966 *Rachela pulchraria* Tayl. Mt. Cheam, B.C., (R. Glendenning).
4085 *Camptogramma stellata* Gn. St. Thomas, Ont., Aug., (James).

Pyraustinae

5178 *Eustixia pupula* Hbn. Pt. Pelee, Ont., July, (Walley).

Phycitinae

Myelois ceratoniae Zell. Toronto, Ont., (Fowler). Bred from shelled almonds.
5705* *Zophodia grossulariae magnificans* Dyar. Wellington, B.C., (Taylor). Inse. Insc. Mens., Vol. XIII, Nos. 10-12, 1925.

The following species have been kindly determined by Miss A. Braun:

Cosmopterygidae

5957 *Cosmopteryx clemensella* Staint. Aweme, Man., July, (Criddle).
7822 *Batrachedra striolata* Zell. Aweme, Man., June, (Criddle).
5985 *Walshia amorphella* Clem. Aweme, Man., June-July, (Criddle).

Gelechiidae

6041 *Aristotelia roseosuffusella* Clem. Aweme, Man., (Criddle).
6073 *Telphusa quinquecristatella* Cham. Nordegg, Alta., (McDunnough).
6119,1 *Gnorimoschema chenopodiella* Busck. Aweme, Man., July, (Criddle).
6139 *Recurvaria obliquistrigella* Cham. Aweme, Man., May, (Criddle).
6145 *Recurvaria quercivorella* Cham. Aweme, Man., June, (Criddle).
6185 *Duvita nigratomella* Clem. Aweme, Man., June, (Criddle); Ottawa, Ont., June, (Young).
6191 *Anacampsis niveopulvella* Clem. Waterton Lake, (McDunnough); Aweme, Man., (Criddle).
6290 *Gelechia fuscotaeniaella* Cham. Aweme, Man., (Criddle).
6357 *Trichotaphe serrativitella* Zell. Aweme, Man., July, (Criddle).
6379 *Dichomeris eupatoriella* Cham. Aweme, Man., May, (Criddle).

Oecophoridae

6450 *Agonopteryx gelidella* Busck. Nordegg, Alta., (McDunnough); Aweme, Man., (Criddle).

Tortricidae

7372 *Tortrix packardiana* Fern. Aweme, Man., July, (Criddle).

Glyphipterygidae

* *Ellabella editha* Busck. Quamichan Lake and Saanikten, B.C., (Blackmore); Waterton Lakes, Alta., (McDunnough).
Proc. Ent. Soc. Wash., Vol. 27, No. 3, 1925.

Gracilariidae

7999 *Parectopa albicostella* Braun. Aweme, Man., (White); Hemmingford, Que., (Petch).

Additions to the List of Canadian Eucosminae sent by E. H. Blackmore, Victoria, B.C.

Eucosminae

Barbara colfaxiana Kft. Fitzgerald, B.C., (W. R. Carter).
Barbara colfaxiana var. *siskiyouana* Kft. Duncan, B.C., (G. O. Day).
Thiodia tarandana Moes. Chilcotin, B.C., (E. R Buckell); Saskatoon, Sask., (King); Nordegg, Alta., (McDunnough); Lethbridge, Alta., (Seamans).
Eucosma dodana Kft. Atlin, B.C., (Bryant); Mt. McLean, B.C., (A. W. Hanham); Mt. Piran, Alta.
Epiblema gratuitana Hein. Duncan, B.C., (Hanham); Victoria, B.C., (Blackmore).
Epinotia subplicana Wlsm. Shawnigan Lake, B.C., (J. Clarke); Wellington, B.C., (Bryant).
Epinotia terracoctana Wlsm. Goldstream, B.C., (Blackmore); Saanichten, B.C., (J. G. Colville); Powell River, B.C., (W. B. Anderson).
Epinotia miscana Kft. Mt. McLean, B.C., (Hanham).

New Localities for Eucosminae sent by E. H. Blackmore, Victoria, B.C.

Petrova burkeana Kft. Atlin, B.C., (Bryant).
Petrova picicolana Dyar. Duncan, B.C., (Hanham).
Thiodia corculana Zell. Creston, B.C., (Hanham).
Thiodia columbiana Wlsm. Chilcotin, B.C., (E. R. Buckell).
Thiodia transversa Wlsm. Chilcotin, B.C., (Buckell).
Thiodia striatana Clem. Mt. McLean, B.C., (Hanham).
Thiodia montanana Wlsm. Chilcotin, B.C., (Buckell).
Eucosma ridingsiana Rob. Vavenby, B.C., (Moilliet).

Eucosma argentialbana Wlsm. Atlin, B.C., (Bryant); Vavenby, B.C., (Moilliet).
Eucosma agricolana Wlsm. Goldstream, B.C., (Blackmore).
Eucosma scintillana var. *randana* Kft. Marron Lake, B.C., (B. B. Green).
Eucosma subflavana Wlsm. Chase, B.C., (Anderson).
Eucosma lolana Kft. Chilcotin, B.C., (Buckell).
Eucosma mediostriata Wlsm. Chilcotin, B.C., (Buckell).
Eucosma dorsisignatana Clem. Vavenby, B.C., (Moilliet).
Eucosma juncticiliana Wlsm. Fraser Mills, B.C., (Marmont).
Epiblema periculosana Hein. Mt. McLean, B.C., (Hanham). Type locality.
Epiblema illotana Wlsm. Victoria, B.C., (Blackmore).
Gypsonoma adjuncta Hein. Victoria, B.C., (Carter).
Gypsonoma fasciolana Clem. Goldstream, B.C., (Blackmore).
Gypsonoma haimbachiana Kft. Vavenby, B.C., (Moilliet).
Gypsonoma substitutionis Hein. Victoria, B.C., (W. R. Carter).
Proteoteras aesculana Riley. Duncan, B.C., (Hanham).
Zeiraphera ratzeburgiana Sax. Victoria, B.C., (Blackmore).
Zeiraphera diniana Gue. Victoria, Goldstream, B.C., (Blackmore).
Exentera improbana Wlk. Goldstream, B.C., (Blackmore).
Exentera oregonana Wlsm. Victoria, B.C., (Blackmore).
Griselda radicana Wlsm. Victoria, B.C., (Blackmore).
Epinotia similana Hbn. Vavenby, B.C., (Moilliet).
Epinotia castaneana Wlsm. Victoria, B.C., (Blackmore).
Epinotia albangulana Wlsm. Victoria, Goldstream, B.C., (Blackmore).
Epinotia nigralbana Wlsm. Saanichten, B.C., (J. G. Colville); Sahtlem, B.C., (Blackmore).
Epinotia crenana Hub. Shawnigan Lake, B.C., (J. Clarke).
Epinotia arctostaphylana Kft. Vavenby, B.C., (Moilliet).
Epinotia medioplagata Wlsm. Chilcotin, B.C., (Buckell); Vavenby, B.C., (Moilliet).
Epinotia plumbolinearia Kft. Fraser Mills, B.C., (Marmont); Goldstream, B.C., (Blackmore).
Epinotia cruciana Linn. Vavenby, B.C., (Moilliet).
Epinotia seorsa Hein. Vavenby, B.C., (Moilliet); Duncan, B.C., (Hanham); Victoria, B.C.
Epinotia vagana Hein. Fraser Mills, B.C., (Blackmore).
Epinotia lindana Fern. Victoria, B.C., (Carter); Lillooet, B.C., (A. Phair).
Epinotia trossulana Wlsm. Brentwood, B.C., (Blackmore).
Anchylopera subaequana Zell. Goldstream, B.C., (Blackmore).
Anchylopera angulifasciana Zell. Brentwood, B.C., (Blackmore).
Anchylopera burgessiana Zell. Fraser Mills, B.C., (Blackmore).
Ancylis apicana Wlk. Fitzgerald, B.C., (Carter); Fraser Mills, B.C., (Blackmore).
Ancylis diminutana Haw. Fraser Mills, B.C., (Marmont).
Hystricophora stygiana Dyar. Mt. McLean, B.C., (Hanham); Goldstream, B.C., (Blackmore).
Hystricophora asphodelana Kft. Atlin, B.C., (Bryant).

Coleoptera

(Arranged according to Lang's "Catalogue of Coleoptera," 1920.)

Carabidae
260 *Pelophilla rudis* Lec. Edmonton, Alta., (Carr).
269* *Nebria schwarzi* Van D. Banff, Alta., (E. A. Schwarz and Van Dyke).
* *Nebria piperi* Van D. Merritt, B.C., (Hopping).
Above two species described in "Pan. Pac. Ent.," Vol. 1, No. 3, 1925.
342 *Dischirius erythrocerus* Lec. Edmonton, Alta., (Carr).
505 *Bembidion nebraskensis* Lec. Edmonton, Alta., (Carr).
661 *Bembidion obtusangulum* Lec. Peachland, B.C., Stoney Mountain, Man., (Wallis); Leduc, Alta., (Carr).
896 *Tachyta californica* Casey. Peachland, B.C., (Wallis).
1141 *Cryobius arcticola* Chd. Mile 332, H.B. Ry., (Wallis).
1547 *Platynus carbo* Lec. Winnipeg, Man., (Wallis).
1665 *Lebia montana* Horn. Medicine Hat, Alta., (Carr).
1862 *Lachnocrepis parallelus* Say. Winnipeg, Man., (Wallis).
1879 *Piosoma setosa* Lec. Medicine Hat, Alta., (Carr).

Amphizoidae
2281 *Amphizoa lecontei* Matth. Pincher Creek, Beaver Creek and Happy Valley, Alta., (Carr).

Haliplidae
2327 *Peltodytes tortulosus* Robts. Redwater, Alta., (Carr).

Dytiscidae
2414 *Coelambus scellatus* Lec. White Lake and Cariboo Rd., B.C., (Criddle, Buckell, Vroom).
2419 *Coelambus musculinus* Cr. White Lake, Nicola Valley, B.C., (Criddle and Vroom).
2421 *Coelambus unguicularis* Cr. White Lake, Nicola Valley, B.C., (Criddle and Vroom); Tofield and Medicine Hat, Alta., (Carr).
Coelambus tumidiventris Fall. Mile 70, Cariboo Rd., B.C., (Criddle, Buckell, Vroom).
Hydroporus similaris Fall. Barkerville, B.C., (Criddle).
Agabus sharpi Fall. Edmonton, Alta., (Carr).
Agabus ajax Fall. Minnie Lake, B.C., (Criddle).
Agabus triton Fall. Edmonton, Alta., (Carr).

Gyrinidae
Longitarsus pallescens Blat. Prince Edward Co., Ont., (Brimley).
Gyrinus wallisi Fall. Edmonton, Alta., (Carr); Ponoha, Alta., (R. D. Bird).

Silphidae
* *Necrophorus hybridus* Hotch & Angell. Aweme, Man., July-August, (Criddle). "Jour. N.Y. Ent. Soc.," Vol. XXXIII, 1925.
2965 *Ptomaphagus parasitus* Lec. Aweme, Man., (R. M. White).

Orthoperidae
3230 *Corylophodes marginicollis* Lec. Birds Hill, Man., (Wallis).

Histeridae
6573 *Hister immunis* Er. Medicine Hat and Cypress Hills, Alta., (Carr).
6867 *Saprinus desertorum* Mors. Medicine Hat, Alta., (Carr).

Oedemeridae
7765 *Ditylus coerulens* Rond. Birds Hill, Man., (Wallis).

Mordelidae
7872 *Mordellistena grammica* Lec. Aweme, Man., (Criddle); Lake of Bays, Ont., (McDunnough).
7859 *Mordellistena comata cervicalis* Lec. Aweme, Man., (Criddle).
7875 *Mordellistena semiustula* Lec. Treesbank, Man., (White).
7896 *Mordellistena smithi* Drury. Aweme, Man., (Criddle).
7900 *Mordellistena sericans* Fall. Aweme, Man., (White).

Elateridae
Ludius lobatus Esch. Winnipeg, Man., (Wallis).
8902 *Agriotes montanus* Lec. Stonewall, Man., (Wallis).
9020 *Melanetus canadensis* Cond. Victoria Beach, Man., (Wallis).

Buprestidae
9321 *Chalcophora liberta* Germ. Victoria Beach, Man., (Mrs. G. S. Brooks).
9346 *Dicerca chrysea* Melsh. Victoria Beach, Man., (Wallis).
9408 *Chrysobothris lecontei* Leng. Onah, Man., (Wallis).
9516 *Agrilus pusillus* Say. Winnipeg, Man., (Roberts and Wallis).
9523d *Agrilus arcuatus obliquus* Lec. Douglas Lake, Man., (Wallis).

Heteroceridae
9644 *Heterocerus pallidus* Say. Aweme and Thornhill, Man., (Wallis).
9653 *Heterocerus auromicans* Kies. Medicine Hat, Alta., (Carr).

Dermestidae
9739 *Dermestes pulcher* Lec. McMunn, Man., (H. Mulligan).

Cucujidae
10199 *Silvanus planatus* Germ. Stonewall, Man., (Wallis).

Lathridiidae
10635 *Coninomus nodifer* Westw. Winnipeg, Man., (Wallis).
10664 *Cartodera filum* Aube. Winnipeg, Man., (Wallis).

Melandryidae
12541 *Hallomenus punctulatus* Lec. Winnipeg, Man., (Wallis).

Bostrichidae
12888 *Amphicerus bicaudatus* Say. Husavick, Man., (Wallis).

Cisidae
13013 *Diphyllocis blaisdelli* Casy. Peachland, B.C. Bred from fungus, (Wallis).

Scarabaeidae
13184 *Aphodius distinctus* Mall. Medicine Hat, Alta., (Carr).
13978 *Cremastochilus incisus* Csy. Medicine Hat, Alta., (Carr).

Cerambycidae
14728 *Anthobasus ruricola* Oliv. Wabamun, Alta., (Carr).
14830 *Crossidius pulchellus* Lec. Medicine Hat, Alta., (Carr).
15182 *Tetraopes femoratus* Lec. Medicine Hat, Alta., (Carr).

Chrysomelidae
* *Donacia emarginata frosti* Schaef. Edmonton, Alta., (Carr); Aweme, Man., (Criddle); Rembrandt, Man., (Mrs. Mulligan); Ontario.
* *Donacia diversa* Schaef. Point Pelee, Ont., (Bigelow).
* *Donacia wallisi* Schaef. Edmonton, Alta., (Carr); Aweme, Man., (Criddle); H. B. Ry., Miles 17-332, (Wallis); Rembrandt, Man., (Mrs. Mulligan).
* *Donacia dubia* Schaef. Glacia, B.C., (Hubbard and Schwarz); Banff, Alta., (Hearle).
* *Donacia longicollis* Schaef. Metlakatla and Inverness, B.C., (Keen).
The above five species described in "Brooklyn Mus. Sci., Bul., Vol. 3, 1925.
Phyllodecta americana Schaef. Cypress Hills, Alta., on aspen, (Carr).
15932 *Haltica vicaria* Horn. Medicine Hat, (Carr).
Haltica heucherae Fall. Edmonton, Alta., (Carr).
Longitarsus suspectus Blat. Prince Edward Co., Ont., (Brimley).
Gyrinus pugionis Fall. Prince Edward Co., Ont., (J. F. Brimley).
16135 *Microrhopala cyanea* Say. Medicine Hat, Alta., (Carr).

Curculionidae
16458 *Apion arizonae* Fall. Edmonton, Alta., (Carr).
15186 *Amphionycha flammala* Newn. Point Pelee, Ont., (G. S. Walley).
16523 *Ophryastes sulcirostris* Say. Medicine Hat, Alta., (Carr).
16727 *Sitona flavescens* Marsh. Peachland, B.C., (Metcalf); Husavick and Victoria Beach, Man., (Wallis).
16885 *Euclyptus rutilus* Fall. Peachland, B.C., (Metcalf).
17009 *Promecotarsus densus* Csy. Cawston, B.C., ((Metcalf); Aweme, Man., (Wallis).
17046 *Bagous transversus* Lec. Winnipeg, Man., (Wallis).
17262 *Anthonomus hirtus* Lec. Aweme, Man., (Wallis).

Diptera

Prepared by C. H. Curran

The past year has been especially noteworthy for the description of a great many new Canadian Diptera and the record is largely composed of records of these new forms. In addition to the usual record, a complete list of the Canadian species of the families Lonchaeidae, Pallopteridae and Sapromyzidae is given. The numbers at the left refer to the page in Aldrich's Catalogue on which the name of the genus appears, while (*) refers to newly described species.

Tipulidae
83* *Antocha obtusa* Alex. Hull, Que., (G. S. Walley). Ent. News, XXXVI, 201, 1925.
* *Cladura flava* Garrett. Radium, B.C., (Described in Garrett's "Seventy New Diptera," 1925).
84* *Erioptera aldrichi* Alex. Valdez, Alaska.
* *Erioptera alaskensis* Alex. Windy, Alaska.
* *Ormosia curvata* Alex. Skagway, Alaska.
* *Ormosia proxima* Alex. Skagway, Alaska.
* *Ormosia decussata* Alex. Ketchikan, Alaska.
* *Rhabdomastix borealis* Alex. Hurricane, Alaska.
The above six species described in Proc. U.S.N.M., LXIV, Art. 10, 1925.

Dixidae
105* *Dixa distincta* Garr. Cranbrook, B.C.
* *Dixa simplex* Garr. Cranbrook, B.C.
Described in Garrett's "Sixty-One New Diptera," 1925.
* *Dixa plexipus* Garrett. Nelson, B.C.
Described in Garrett's "Seventy New Diptera," 1925.

Chironomidae
117* *Diamesia confusa* Garrett. Cranbrook, B.C.
* *Diamesia banana* Garrett. Cranbrook and Fernie, B.C.
* *Diamesia borealis* Garrett. Cranbrook, B.C.

117* *Diamesia lurida* Garrett. Cranbrook, B.C.
* *Prodiamesia pertinax* Garrett. Cranbrook and Michel, B.C.
* *Prodiamesia sequax* Garrett. Cranbrook, B.C.
* *Prodiamesia lutosopra* Garrett. Cranbrook, B.C.
* *Prodiamesia cubita* Garrett. Fernie, B.C.
* *Tanypus arcuatus* Garrett. Cranbrook, B.C.
* *Tanypus trifolia* Garrett. Cranbrook, B.C.
* *Tanypus abruptus* Garrett. Cranbrook, B.C.
* *Tanypus bifida* Garrett. Cranbrook, B.C.
* *Paratanypus kiefferi* Garrett. (Gen.n.) Cranbrook, B.C.
* *Linacerus piloala* Garrett. (Gen.n.) Cranbrook, B.C.
* *Isoecacta poeyi* Garrett. (Gen.n.) Cranbrook, B.C.
* *Procladius malifero* Garrett. Cranbrook, B.C.
111* *Corynoneura cubitus* Garrett. Cranbrook, B.C.

Orphnephilidae
173* *Orphnephila pilosa* Garrett. Marysville, B.C.
* *Orphnephila fusca* Garrett. Marysville, B.C.
All the above new Chironomidae and Orphnephilidae described in Garrett's "Seventy New Diptera," 1925.

Culicidae

134* *Aedes labradorensis* Dyar and Shannon. Labrador.
* *Aedes pearyi* Dyar and Shannon. Labrador.
The preceding two species described in Jour. Wash. Acad. Sci., XV, 78.
Aedes lazarensis F. & V. Onah and Aweme, Man., (N. Criddle).

Mycetophilidae
* *Neuratelia abrevena* Garrett. Marysville, B.C.
* *Empalia disjuncta* Garrett. Marysville, B.C.
143* *Leia cephala* Garrett. Marysville, B.C.
147* *Dynotosoma montanus* Garrett. Marysville, B.C.
* *Dynotosoma huliphila* Garrett. Cranbrook, B.C.
* *Dynotosoma huliphila grandis* Garrett. Cranbrook and Bull River, B.C.
143* *Docosia setosa* Garrett. Michel, B.C.
* *Docosia affinis* Garrett. Marysville, B.C.
* *Docosia similis* Garrett. Fernie, B.C.
* *Docosia aceus* Garrett. Cranbrook, B.C.
* *Docosia nigrita* Garrett. Marysville, B.C.
* *Docosia vierecki* Garrett. Nelson, B.C.
* *Docosia apicula* Garrett. Fernie and Michel, B.C.
* *Docosia nebulosa* Garrett. Vancouver, B.C.
* *Cordyla verio* Garrett. Cranbrook, B.C.
* *Cordyla scutellata* Garrett. Nelson, B.C.
* *Cordyla confera* Garrett. Cranbrook, B.C.
* *Cordyla parva* Garrett. Cranbrook, B.C.
144* *Zygomyia pilosa* Garrett. Marysville and Cranbrook, B.C.
* *Zygomyia bifasciata* Garrett. Cranbrook and Marysville, B.C.
* *Zygomyia christulata* Garrett. Cranbrook and Marysville, B.C.
* *Zygomyia christata* Garrett. Cranbrook, B.C.
* *Zygomyia coxalis* Garrett. Cranbrook and Marysville, B.C.
* *Sceptonia johannseni* Garrett. Cranbrook and Marysville, B.C.
* *Sceptonia autumnalis* Garrett. Cranbrook and Marysville, B.C.
The above described in Garrett's "Seventy New Diptera," 1925.
140* *Sciophila longua* Garrett. Cranbrook, B.C.
* *Sciophila neohebes* Garrett. Cranbrook, B.C.
* *Sciophila agassis* Garrett. Agassiz, B.C.
* *Sciophila bicolor* Garrett. Marysville, B.C.
* *Sciophila bifida* Garrett. Fernie, B.C.
* *Sciophila distincta* Garrett. Cranbrook, B.C.
* *Sciophila parvus* Garrett. Fernie, B.C.
* *Sciophila fusca* Garrett. Cranbrook, B.C.
* *Sciophila setosa* Garrett. Cranbrook, B.C.
* *Sciophila acuta* Garrett. Cranbrook, B.C.
140* *Tetragoneura similas* Garrett. Cranbrook, B.C.
* *Tetragoneura robur* Garrett. Cranbrook, B.C.
142* *Boletina punctus* Garrett. Creston, B.C.
* *Boletina magna* Garrett. Fernie, B.C.
* *Monoclona simplex* Garrett. Caulfields, B.C.
143* *Leia hemiata* Garrett. Bull River, B.C.
* *Leia shermani* Garrett. Agassiz, B.C.

Mycetophilidae
144* *Odontopoda distincta* Garrett. Agassiz, B.C.
* *Neuratelia obscura* Garrett. Cranbrook, B.C.
* *Neuratelia grandis* Garrett. Marysville, B.C.
* *Anatella difficilis* Garrett. Vancouver, B.C.
147* *Macrocera variola* Garrett. Cranbrook, B.C.
* *Macrocera bicolor* Garrett. Cranbrook, B.C.
* *Macrocera uniqua* Garrett. Cranbrook, B.C.
* *Macrocera pilosa* Garrett. Cranbrook, B.C.
* *Macrocera villosa* Garrett. Fernie, B.C.
* *Macrocera similis* Garrett. Michel, B.C.
* *Macrocera distincta* Garrett. Cranbrook, B.C.
147* *Bolitophila simplex* Garrett. Cranbrook, B.C.
* *Bolitophila perlata* Garrett. Bull River, B.C.
* *Bolitophila duplus* Garrett. Cranbrook, B.C.
* *Bolitophila raca* Garrett. Crow's Nest, B.C.
* *Bolitophila connectans* Garrett. Michel, B.C.
* *Bolitophila recurva* Garrett. Michel, B.C.
* *Bolitophila clavata* Garrett. Michel, B.C.
* *Bolitophila acuta* Garrett. Michel, B.C.
* *Bolitophila subteresa* Garrett. Cranbrook, B.C.
* *Bolitophila bilobata* Garrett. Cranbrook, B.C.
* *Symmerus coquila* Garrett. Cranbrook, B.C.
* *Ceratelion fasciata* Garrett. Cranbrook, B.C.
164* *Hesperinus flagellaria* Garrett. Cranbrook, B.C.
* *Eudicrana plexipus* Garrett. Vancouver, B.C.
The above described in Garrett's "Sixty-One New Diptera," 1925.

Sciaridae
148* *Sciara diderma* Garrett. Cranbrook, B.C.
* *Sciara diota* Garrett. Cranbrook, B.C.
* *Sciara clavata* Garrett. Nelson, B.C.
* *Sciara arcuata* Garrett. Cranbrook, B.C.
* *Sciara unicorn* Garrett. Cranbrook, B.C.
The above new species described in Garrett's "Seventy New Diptera," 1925.
Sciara caldaria Lint. Medicine Hat, Alta., Dec., (F. S. Carr).

Stratiomyidae
189 *Nemotelus bonnarius* Johns. Salmon Arm, B.C., July, (Dennys).

Tabanidae
* *Tylostypia labradorensis* Enderlein. Labrador, (subgen. of Tabanus, C.H.C.) (Mitt. Zool. Mus. Berlin, XI, 363, 1925).

Asilidae
219 *Pogonosoma dorsata* Say. Victoria Beach, Man., June, July, Aug., (G. S. Brooks).
Pogonosoma ridingsi Cresson. Waterton, Alta., July, (Strickland); Lillooet, B.C., June, (Ruhmann); Departure Bay, B.C., (Hanham).

Dolichopodidae
287 *Mesorhaga pallicornis* V.D. Pt. Pelee, Ont., July, (G. S. Walley); Aweme, Man., July, (N. Criddle).
288 *Diaphorus opacus* Loew. Smith's Cove, N.S., Aug., (A. Gibson).
289 *Chrysotus convergens* V.D. Aylmer, Que., Aug., (Curran).
Chrysotus johnsoni V.D. Aylmer, Que., Aug., (Curran).
291 *Argyra nigricoxa* V.D. Orillia, Ont., June, (Curran).
* *Argyra setipes* V.D. Orillia, Ont., July, (Curran).
* *Argyra albicoxa* V.D. Hull, Que., July, (Curran).
* *Argyra bimaculata* V.D. Hull, Que., June, (Curran).
* *Argyra sericata* V.D. Hull, Que., June, (Curran); Rigaud, Que., June.
* *Argyra currani* V.D. Hull, Que., June, Orillia and Sebright, Ont., July, (Curran); Pt. Pelee, Ont., June, (Walley).
* *Argyra thoracica* V.D. Kearney, Ont., (V. Duzee).
* *Argyra velutina* V.D. Hull, Que., June; Covey Hill, Que., June, (Curran).
292 *Rhaphium punctitarsis* Curran. Aweme, Man., May, (N. Criddle).
292 *Parasyntormon emarginicornis* Curran. Nicola, B.C., (Criddle).
293 *Neurigona infuscata* V.D. Orillia, Ont., June, (Curran).
Neurigona arcuata V.D. Orillia, Ont., June, (Curran).
295 *Thinophilus ochrifacies* V.D. Smith's Cove, N.S., Aug., (A. Gibson).
295 *Medetera trisetosus* V.D. Frater, Ont., June, (E. R. Watson).
Medetera halteralis V.D. Low Bush, Lake Abitibi, Ont., Aug., (N. K. Bigelow).
Medetera lobatus V.D. Orillia, Ont., June, (Curran).
Medetera viduus Wheeler. Low Bush, Lake Abitibi, Ont., July, Aug., (N. K. Bigelow).
296* *Hydrophorus criddlei* V.D. Aweme, Man., (N. Criddle).

296* *Hydrophorus fulvidorsum* V.D. Chin, Alta., (H. L. Seamans).
The above described in "Psyche," XXXII, 181-182, 1925.
Hydrophorus aestuum Loew. Shoal Lake, Man., Sept., (Criddle).
Hydrophorus chrysologus Walk. Victoria Beach, Sept., and Aweme, Man., May, (N. Criddle).
297 *Scellus vigil* O.S. Banff, Alta., Aug., (E. Hearle).
298 *Liancalus hydrophilus* Ald. Banff, Alta., Oct., and Lake Louise, Alta., Sept., (E. Hearle).
298 *Dolichopus maculitarsis* V.D. Baldur, Man., (R. D. Bird); Chin, Alta., May, (W. Carter). (Described in "Psyche," XXXII, 184, 1925). NWT
Dolichopus alacer V.D. Pt. Pelee, Ont., June, (Walley); Baldur, Man., June, (Criddle).
Dolichopus nigrilineatus V.D. Victoria Beach, Man., July, (Brooks).
Dolichopus aldrichi Wheeler. Nicola and Douglas Lake, B.C., July, (Criddle).
Dolichopus barbicauda V.D. Salmon Arm, B.C., June, (A. A. Dennys).
Dolichopus brevipennis Meigen. Minnie Lake, B.C., July, (Criddle).
Dolichopus celeripes V.D. Low Bush, Lake Abitibi, Ont., July, (Bigelow).
Dolichopus chrysostoma Loew. Orillia and Severn, Ont., June, (Curran).
Dolichopus cuprinus Wd. Salmon Arm, B.C., Aug., (Dennys).
Dolichopus defectus V.D. Transcona, Man., July, (G. S. Brooks).
Dolichopus flavicoxa V.D. Stockton and Glen Souris, Man., June, July, (Criddle); Salmon, Arm, B.C., June, (Dennys).
Dolichopus lobatus Loew. Salmon Arm, B.C., June, (Dennys).
Dolichopus longimanus Loew. Hemmingford, Que., June, (Curran); Minnie Lake, B.C., July, (E. R. Buckell).
Dolichopus myosota O.S. Oliver, B.C., April, (C. Garrett).
Dolichopus nigricauda V.D. Baldur, Man., June, (Criddle).
Dolichopus stenhammari Zett. Low Bush, Lake Abitibi, Ont., July, Aug., (N. K. Bigelow).
Dolichopus varipes Coq. Barkerville, B.C., Aug., (Criddle).
305 *Gymnopternus crassicaudus* Loew. Smith's Cove, N.S., Aug. 6, (A. Gibson).
306* *Hercostomus purpuratus* V.D. Stockton, Man., (Criddle).
307 *Paraclius claviculatus* Loew. Smith's Cove, N.S., Aug., (Gibson).
308 *Pelastoneurus abbreviatus* Loew. Smith's Cove, N.S., Aug., (Gibson).
Pelastoneurus neglectus Wheeler. Orillia, Ont., June, (Curran).

Syrphidae

354 *Baccha fuscipennis* Say. Normandale, Ont., June, (Walley).
Baccha costalis Wied. Pt. Pelee, Ont., July, (Walley).
362* *Didea daphne* Hull. Keremeos, B.C., (Garrett). (Is a Syrphus, C.H.C.) (Described in "Ann. Ent. Soc. Am.," XVIII, 280, 1925).
Syrphus (*Didea*) *laxa syrphoides* Hull. Hull, Que., June, (Curran).
* *Syrphus palliventris* Curran. Nordegg, Alta., June, (McDunnough).
* *Syrphus rufipunctatus* Curran. Lillooet, B.C., July, (Treherne).
* *Syrphus neoperplexus* Curran. Hussavick, Man., July, (Wallis).
* *Syrphus osburni* Curran. Orillia, Ont., May, (Curran).
* *Syrphus laticaudatus* Curran. Victoria, B.C., May, (Treherne).
* *Syrphus laticaudus* Curran. Orillia, Ont., May, (Curran); Hull, Que., May, June, (Curran).
* *Epistrophe albipunctatus* Curran. B.C.
* *Epistrophe columbiae* Curran. Chilcotin, B.C., (Buckell); Cranbrook, B.C., (Garrett).
* *Epistrophe diversipunctatus* Curran. Orillia, Ont., May, Sept., (Curran).
* *Epistrophe garretti* Curran. Bull River, B.C., May, (Garrett); Banff, Alta., June, (Sanson).
* *Epistrophe hunteri* Curran. Teulon, Man., May, (A. J. Hunter).
* *Epistrophe imperialis* Curran. Abitibi region, Que., (Dr. Cook); Winnipeg, Man.; Macdiarmid, Ont., June, (Bigelow).
* *Epistrophe submarginalis* Curran. Orillia, Ont., May, June, (Curran).
* *Epistrophe subfasciatus* Curran. Banff, Alta.
* *Epistrophe terminalis* Curran. Ottawa, Ont., (McDunnough).
360* *Melanostoma confusum* Curran. Orillia, Ont., May, (Curran); Aylmer, Que., May, (McDunnough); Hull, Que., April, May, (Curran).
348* *Chrysogaster ontario* Curran. Orillia, Ont., May, June, and Guelph, Ont., July, (Curran).
(The preceding species described in Kans. Univ. Sci. Bull., Vol. 15, Dec. 1, 1925).
375* *Neoascia conica* Curran. Banff, Alta., (Garrett).
* *Neoascia sphaerophoria* Curran. Banff, Alta., (Garrett).
* *Neoascia subchalybea* Curran. Montreal, Que., (Ouellet).
* *Neoascia unifasciata* Curran. Aweme, Man., (Criddle).
(The preceding species described in "Proc. Ent. Soc. Wash., XXVII, 1925).
* *Cynorhina nigripes* Curran. Victoria, B.C., April, (Treherne); Vancouver, B.C., June.
* *Cynorhina armillata hunteri* Curran. Teulon, Man., (A. J. Hunter).

Syrphidae

402* *Criorhina mystaceae* Curran. Halifax, N.S., June, (J. Perrin).
* *Criorhina caudata* Curran. Salmon Arm, Cranbrook, Hawser Lake and Kaslo, B.C., (Buckell, Garrett).
(The above species described in "Kans. Univ. Sci. Bull.," XV, Dec. 1, 1925).
Parhelophilus obsoletus Loew. Victoria Beach, Man., July, (Brooks).
Helophilus groenlandicus O. Fabr. Victoria Beach, Man., July, (Brooks).
384 *Eristalis rupium* Fabr. Aweme, Man., Aug., (Criddle).
* *Eristalis mellissoides* Hull. British Columbia.
"Ohio Journal of Science," XXV, 1925.
* *Microdon albipilis* Curran. "Manitoba."
* *Microdon basicornis* Curran. Barber Dam, N.B., June, (Tothill).
"Kans. Univ. Sci. Bull.," XV, 1925.

Conopidae

410 *Zodion obliquefasciata* Macq. Medicine Hat, Alta., July, (F. S. Carr).

Tachinidae

* *Phasia furva* West. Truro, N.S., (Matheson).
"Jour. N.Y. Ent. Soc.," XXXIII, 1925.
Clausicella tarsalis Coq. Transcona, Man., July, (G. S. Brooks).
450 *Cylindromyia (Ocyptera) euchenor* Walk. Medicine Hat, Alta., July, (F. S. Carr).
451* *Linnaemyia nigrescens* Curran. Hedley, B.C., (C. Garrett).
* *Linnaemyia varia* Curran. Hopedale, Labr., (Perrett).
These two species described in "Ent. News," XXXVI, 1925.
Mericia johnsoni Toth. Montreal, Que., May, (J. Ouellet); Orillia, Ont., June, (Curran).
Mericia longicarina Toth. Waterton, Alta., July, (Seamans).
Mericia platycarina Toth. Aweme, Man., July, (Criddle).
Lydella polita Tns. (*L. connecta* Curran). Transcona, Man., July, (Brooks).
480 *Gaediopsis ocellaris* Coq. Winnipeg, Man., July, (A. V. Mitchener).
Microphthalma michiganensis Tns. (*M. phyllophagae* Curr.). Hemmingford, Que., (G. H. Hammond); Aylmer, Que., (Curran); Strathroy, Ont., (Hudson).
Fabriciella canadensis Toth. Waterton, Alta., July, (Seamans).
484* *Peleteria alberta* Curran. Banff, Alta., (C. Garrett).
* *Peleteria angulata* Curran. Hedley, B.C., (Garrett).
* *Peleteria biangulata* Curran. Salmon Arm, B.C., July, (A. A. Dennys).
* *Peleteria bryanti* Curran. Alberta, Man., British Columbia, Saskatchewan.
* *Peleteria campestris* Curran. Alberta, B.C., Man., Sask.
* *Peleteria clara* Curran. Lethbridge, Alta., (Strickland, Carter); Calgary, Alta., (O. Bryant); London Hill Mine, B.C., (Currie).
* *Peleteria confusa* Curran. Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, Quebec, New Brunswick, Nova Scotia.
* *Peleteria conjuncta* Curran. Nicola, B.C., (P. Vroom).
* *Peleteria cornigera* Curran. Lillooet, B.C., (Phair).
* *Peleteria cornuta* Curran. Tincher and Cypress, Alta., (Strickland); Calgary, Alta., (J. Fletcher).
* *Peleteria cornuticaudata* Curran. Banff, Alta., (Garrett); Barkerville, B.C., Aug., (N. Criddle).
* *Peleteria eronis* Curran. Alberta (Strickland, Cameron); British Columbia, (Anderson, Wilson); Manitoba, (Vroom, Wallis).
* *Peleteria phairi* Curran. Lillooet, B.C., July, (Phair); Banff, Alta., Aug., (Garrett).
The above species described in "Trans. Royal Soc. Can.," XIX, 1925.

Sarcophagidae

510* *Sarcophaga morosa* Aldrich. Ottawa, Ont.
"Proc. U.S.N.M.," LXVI, Art. 18, 1925.

Muscidae (Anthomyidae)

534 *Hydrotaea dentipes* Fabr. Macdiarmid, Ont., July, (N. K. Bigelow).
Hydrotaea houghi Mall. Macdiarmid, Ont., July, (Bigelow).
542 *Trichopticus johnsoni* Mall. Off Fame Point, N.W.T., July, (R. Finnie).
Helina nigricans Stein. Transcona, Man., June, (Brooks).

Helomyzidae

572* *Anorostoma hinei* Garrett. Alaska, July, (Hine).
* *Spanoparia walkeri* Garrett. Marysville, B.C., July, Aug., (Garrett).
* *Postleria diversa* Garrett. Marysville, B.C., Aug., (Garrett).
The above described in Garrett's "Seventy New Diptera," 1925.
* *Postleria czerni* Garrett. Alaska.
* *Suillia loewi* Garrett. British Columbia (Garrett).
* *Helomyza serrata americana* Garrett. "Canada."
* *Amoebaleria gonea* Garrett. Fernie, B.C., October, (Garrett).
* *Amoebaleria fraterna hyalina* Garrett. Cranbrook, B.C., (Garrett); Alaska, (Hine).
* *Amoebaleria triangulata* Garrett. Yukon, B.C., (Garrett).
The above described in Garrett's "Sixty-One New Diptera," 1925.

Borboridae
* *Leptocera maculipennis* Spuler. "British Columbia."
* *Leptocera abundans* Spuler. Kaslo, B.C., (Currie).
Described in "Jour. N.Y. Ent. Soc.," XXXIII, 1925.

Ortalidae
597 *Seioptera colon* Loew. Transcona, Man., July, (G. S. Brooks).

Ephydridae
629* *Ephydra pacifica* Cresson. "British Columbia," (Crew).
"Ent. News," XXXVI, 167, 1925.

Drosophilidae
640 *Stegana alboguttata* Wahl. Low Bush, Lake Abitibi, Ont., Aug., and Macdiarmid, Ont., July, (N. K. Bigelow).

Following is a list of Canadian species of Lonchaeidae, Pallopteridae and Sapromyzidae, giving the distribution of species as shown by representatives in the Canadian National Collection. Other species have been recorded but the determination must be verified.

Lonchaeidae
Lonchaea polita Say. Ontario and Quebec, (Beaulne, Beaulieu, Curran, Evans, Walley, Hewitt and Gibson). Common May to September.
Lonchaea nudifemorata Malloch. Trenton, Ont., (J. D. Evans); Aylmer, Que., Aug., (Curran).
Lonchaea subpolita Malloch. Low Bush, Lake Abitibi, Ont., July, (N. K. Bigelow).
Lonchaea nigrociliata Malloch. Chilcotin, B.C., June, (E. R. Buckell).
Lonchaea occidentalis Malloch. British Columbia, (Hopping).
Lonchaea laticornis Meigen. Low Bush, Lake Abitibi, Ont., July, Aug., (N. K. Bigelow).
Lonchaea aberrans Malloch. Kentville, N.S., May, (R. P. Gorham).
Lonchaea vaginalis Fallen. Chatham, Trenton and Ottawa, Ont., (Walley, Curran, Ide, Evans); Montreal, Chicoutimi and Hull, Que., (Beaulieu, Beaulne); Teulon, Man., (W. Chesney). Early May to September.
Lonchaea quadrisetosa Malloch. Reared from birch log at Experimental Farm, Ottawa, June, 1919, (C. B. Hutchings); Rigaud, Que., June, (Jos. Ouellet).
Lonchaea albiceps Malloch. Ottawa, Ont., July, (Curran); Aweme, Man., June, (R. M. White).
Lonchaea ruficornis Malloch. Belleville, Ont.
Lonchaea affinis Malloch. Low Bush, Lake Abitibi, Ont., July, (Bigelow).

Sapromyzidae
Lauxania cylindricornis Fabricius. Kentville, N.S., June, July, (R. P. Gorham); Ft. Coulonge, Que., July, (Beaulne); Rigaud, Que., June, (Beaulieu); Meach Lake, Que., June, (A. Gibson); Aweme, Man., June, (Criddle, N. Robertson); Vernon, B.C., May, July, (M. H. Ruhmann, Downes); Chilcotin and Fairview, B.C., June, (Buckell, Anderson); Fort Simpson, Mackenzie River, June, (C. H. Crickmay)
Camptoprosopella vulgaris Fitch. Kentville, N.S.; Joliette, Outremont, Montreal and Fort Coulonge, Que.; Trenton, Ottawa, Bowmanville, Strathroy and Jordan, Ont.; Treesbank, Man., Saskatoon, Sask. Specimens collected by Gorham, Ouellet, Beaulieu, Beaulne, Evans, Fletcher, Ross, Hudson, Curran, Criddle and King.
Melanomyza gracilipes Loew. Aylmer, Que., Aug., (Curran); Jordan, Ont., Aug., (W. A. Ross); Ottawa, Ont., June, (W. Metcalfe).
Minettia americana Malloch. Cottage Beaulieu and Rideau, Que., (Beaulieu); Covey Hill, Que., (T. Armstrong, G. S. Walley); Aylmer, Que., (McDunnough, Viereck); Trenton, Ont., (Evans); Lobo, Ont., (A. A. Wood); Salmon Arm, B.C., (A. A. Dennys).
The dates range from May to August.
Minettia obscura Loew. Hemmingford, Que., (G. Hammond); Meach Lake, Que., (A. Gibson); Ottawa, Ont., (Walley); Aweme, Man., (Criddle). May to July.
Minettia lupulina Fabricius. Kentville, N.S., (Gorham); Fort Coulonge and Hull, Que., (Beaulne); Montreal, Que., (Beaulieu); Ottawa, Muskoka, Orillia, Point Pelee, Toronto and Jordan, Ont., (H. S. Parrish, Viereck, Walley, Walker, Bigelow, Ross); Manitoba, (Criddle); Saskatoon, Sask., (King); Lethbridge, Alta., (Seamans, Strickland); Salmon Arm, B.C., (Dennys); Fort Wrigley, N.W.T., July, (C. H. Crickmay). Very common during the summer.
Minettia flaveola Coquillett. Arrowsmith, B.C., (Jas. Fletcher); Lethbridge, Alta., June, (H. L. Seamans).
Sapromyza serrata Malloch. Aylmer, Que., July, (Curran); Ottawa, Ont., July, (G. Beaulieu); Norway Point, Ont., July, (McDunnough); Ottawa, (W. Metcalfe).
Sapromyza quadrilineata Loew. Kentville, N.S., July, (R. P. Gorham); Montreal, Que., July.

Sapromyzidae

Sapromyza annulata Melander. Montreal, Que., July, (Beaulieu); St. John's, Que., Brockville, Ont., August, (Metcalfe); Ottawa, Ont., June, July, (Metcalfe, Beaulieu); Minnie Lake, B.C., July, (Buckell); Salmon Arm, B.C., June, (Dennys).

Sapromyza pictiventris Malloch. Rigaud, Que., June, (Beaulieu); Aweme, Man., (N. Criddle).

Sapromyza rotundicornis Loew. Ottawa, Ont., July, (Curran); Brockville, Ont., August, (Metcalfe); Trenton, Ont., (Evans).

Sapromyza nigerrima Melander. Salmon Arm, B.C., August, (Dennys).

Sapromyza hyalinata Meigen. Hull, Que., July, (J. I. Beaulne); Ottawa, Ont., Aug., (J. Fletcher); Norway Point, Lake of Bays, Ont., July, (McDunnough).

Sapromyza bispina Loew. Lethbridge, Alta., July, (E. H. Strickland).

Sapromyzosoma fraterna Loew. Ottawa, Ont., Aug., (J. I. Beaulne); Norway Point, Lake of Bays, Ont., Aug., (McDunnough).

Sapromyzosoma compedita Loew. Kentville, N.S., July, (Gorham); Aylmer, Que., Aug., (Curran); Ottawa, Ont., June, (Beaulne); Brockville, Ont., Aug., (Metcalfe).

Sapromyzosoma cyclops Melander. Lethbridge, Alta., June, (H. L. Seamans); Oliver, B.C., May, (Garrett).

Sapromyzosoma disjuncta Johnson. Hemmingford, Que., July, (Hammond); Aylmer, Que., July, (Curran); Ottawa, Ont., July, (Curran).

Sapromyzosoma sheldoni Coquillett. Ottawa, Ont., June, (Metcalfe).

Sapromyzosoma philadelphica Macquart. Cottage Beaulieu, Que., Aug., (Beaulieu); Brule River Camp, Northern Quebec, July, Aug.; Port Hope, Ont., May, (Metcalfe).

Sapromyzosoma incerta Malloch. Cottage Beaulieu, Que., Aug., (Beaulieu); Ottawa, Ont., June, Aug., (Metcalfe, Curran); Norway Point, Lake of Bays, Ont., Aug., (McDunnough).

Sapromyzosoma littoralis Malloch. Lanoraie, Que., June, (G. Beaulieu); Hull, Que., (Beaulne); Ottawa, Ont., (Beaulne, Beaulieu); Aweme, Man., May, (R. D. Bird); Strathroy, Ont., (Hudson).

* *Sapromyzosoma nudifemur* Malloch. Kaslo, B.C., (Currie). "Proc. U.S.N.M.," LXV, Art. 12, 1925.

Sapromyzosoma fratercula Malloch. Kentville, N.S., June, July, (Gorham); Lanoraie, Que., June, (G. Beaulieu); Berthier, Que., May, (J. Ouellet); Fort Coulonge, Que., July, (J. I. Beaulne); Ottawa, Ont., (G. Beaulieu, J. I. Beaulne); Jordan, Ont., (Ross, Curran); Teulon, Man., (A. J. Hunter).

Sapromyzosoma seticauda Malloch. Ottawa, Ont., July, Aug., (G. Beaulieu).

Pallopteridae

Palloptera jucunda Loew. Inverness, B.C., (J. H. Keen); Vernon, B.C., Oct., (W. Downes); Vancouver, B.C., June, (Hanham).

Palloptera superba Loew. Normandale, Ont., June, (Walley); Ottawa, Ont., June, July, (W. Metcalfe, F. Ide); Hull, Que., July, (Ide); Aweme, Man., Aug., (N. Criddle)

Hymenoptera

Prepared by H. L. Viereck

Vipionidae

Apanteles (Protapanteles) militaris Walsh. Chatham, Ont., Aug. 26th, 1925, (A. B. Baird).

Evaniidae

Gasteruption micrurus Kieff. Husavick, Man., July 7, 1910, (J. B. Wallis).

Ichneumonidae

Amblyteles (Cratichneumon) discus Cress. Husavick, Man., July 8, 1910, (J. B. Wallis).

Chlorolycorina albomarginata Cress. Aweme, Man., July 9, 1925, (R. D. Bird).

Cylloceria sexlineata Say. Aweme, Man., July 6, 9, 17, 1924, (R. M. White).

(Pimpla) Epiurus pterophori Ashm. Winnipeg, Man., Sept. 4, 1909, (J. B. Wallis).

Eremotylus texanus Ashm. Aweme, Man., June 22, 1922, (R. M. White).

Glypta militaris Cress. Aweme, Man., July 5, 9, 1924, (R. D. Bird).

Lissonota coloradensis Cress. Aweme, Man., July, 22, 1922, (R. M. White).

(Casinaria) Neonortonia orgyiae How. Aweme, Man., Aug. 12, 1924, ex ***Hemerocampa leucostigma***, (R. D. Bird).

Orthopelma mediator Thunb. Hemmingford, Que., July 31, Aug. 1, 1925, ex ***Diplolepis rosae*** L., (G. H. Hammond).

Phytodietus pleuralis Cress. Sudbury, Ont., 1891, June 6, 1892, (Evans); Aweme, Man., May 27, 1922, (R. M. White).

Phytodietus pulcherrimus Cress. Transcona, Man., July 10, 1924, (G. S. Brooks).

Rhyssa skinneri Vier. var. Aweme, Man., June 30, July 12, 1922, (R. M. White).

Sagaritis ruficoxalis Vier. Aweme, Man., July 10, 1922, (R. M. White).

Xorides catomus Davis. Creston, B.C., May 30, 1924, (C. S. Lallamand).

Zaleptopygus mordellistenae Cush. Treesbank, Man., July 16, 1924, ex ***Mordellistena aemula***, (R. M. White).

The following Ichneumonidae are treated in the Transactions of the Royal Society of Canada' Vol. XIX, 3rd series, pp. 259-273, 1925.

* *Nothanomaloides stenosomus* Vier. Ontario, (Evans).
* *Idiosomidea secunda* Vier. Alberta, (O. Bryant).
* *Campoplegidea walleyi* Vier. Quebec, (G. S. Walley).
* *Campoplegidea vibecifera* Vier. Ontario, (W. H. Harrington).
* *Campoplegidea okanaganensis* Vier. Manitoba, (G. S. Brooks); British Columbia.
* *Campoplegidea stricklandi* Vier. Alberta, (E. H. Strickland).
* *Campoplegidea seamansi* Vier. Alberta, (H. L. Seamans).
* *Campoplegidea rossi* Vier. Ontario, (C. H. Curran).
* *Campoplegidea planatella* Vier. Alberta, (H. L. Seamans).
* *Campoplegidea planata* Vier. Ontario, (James Fletcher).
* *Campoplegidea crassata* Vier. Quebec.
* *Campoplegidea egregiata* Vier. British Columbia, (W. Downes).
* *Campoplegidea edmontonensis* Vier. Alberta, (C. Bryant).
* *Campoplegidea downesi* Vier. British Columbia (W. Downes), (R. H. Chrystal).
* *Campoplegidea diversicolor* Vier. Ontario.
* *Campoplegidea citriscopa* Vier. Ontario, (C. H. Curran); British Columbia.
* *Campoplegidea brooksi* Vier. Manitoba, (C. S. Brooks); Alberta, (H. L. Seamans).
* *Campoplegidea signata* Vier. Ontario, (Evans); Manitoba, (N. Criddle), (C. S. Brooks).

The following three species described in "Proc. U.S. Nat. Mus.", Vol. 64, 1925.

* *Cidaphus occidentalis* Cush. Revelstoke, B.C., (Currie).
* *Protarchoides mandibularis* Cush. Wellington, B.C., (C. W. Johnson).
* *Parabates cristatoides* Cush. Kaslo, B.C., (Currie).

Belytidae

Pseudomethoca propinqua Cress. Medicine Hat and Lethbridge, Alta., Aug. 20, 1916, (Sladen), and Aug. 26, 28, 1912, (J. B. Wallis), respectively.

Halictidae

Halictus (*Evylaeus*) *pectoraloides* Ckll. British Columbia; Okanagan Falls, June 3, 1919, (E. R. Buckell); Summerland, June 4, 1919, Penticton, May 20, June 2, 22, 1919, (E. R. Buckell).

Halictus (*Evylaeus*) *ovaliceps* Ckll. Penticton, B.C., June 7, 1918, (E. R. Buckell); Vernon, B.C., June 7, 1919, (E. P. Venables).

Halictus (*Agapostemon*) *femoratus* Crawford. Okanagan Falls, B.C., June 8, 1913, (E. M. Anderson).

Andrenidae

Andrena (*Andrena*) *vernoni* Vier. Cranbrook, B.C., May 12, 1922, (C. B. D. Garrett).

Andrena (*Andrena*) *erythrogaster* var. *rhodura* Ckll. Ottawa, Ont., April 23, 1913, April 29, 1916, May 20, 1918, (F. W. L. Sladen), May 25, 1896; Ironsides, Que., April 28, 1916.

Andrena (*Andrena*) *erythrogaster* var. *subaustralis* Ckll. Ottawa, Ont., April 25, 1913, May 9, 1914, April 24, 1915, (F. W. Sladen); Ironsides, Que., May 7, 1916, Montreal, May 4, 1906, (Beaulieu); Fairview, B.C., May 18, 1919, (E. R. Buckell); Vasseau Lake, April 9, 1921, (F. W. Sladen).

Andrena (*Andrena*) *placida* Sm. Ottawa, Ont., April 25, 1913, May 3, 30, 1914, May 24, 1915, (F. W. L. Sladen), April 21, 1912, (J. I. Beaulne); Hull, Que., May 14, 1916, (F. W. L. Sladen); Montreal, Que., May 4, 1906 (Beaulieu); Kazabazua, June 3, 1917, blackberry, (F. W. L. Sladen); Annapolis, N.S., May 22, 1912, (C. G. Hewitt); St. John, N.B., June 9, 1901, May 18, 1902, (A. G. Leavitt); May 4, 1902, (W. McIntosh).

Andrena (*Andrena*) *illinoensis* Rob. Winnipeg, Man., May 7, 1910, (J. B. Wallis).

Andrena (*Parandrena*) *mendosa* Vier. Penticton, B.C., April 15, 23, 1919, (E. R. Buckell).

Macropidae

Macropis morsei Rob. Orillia, Ont., July 26, 28, 30, Aug. 2, 1924, (H. L. Viereck); Hull, Que., July 8, 1923, on flowers of *Steironema ciliatum*, (H. L. Viereck); Aylmer, Que., June 21, 1915, (F. W. L. Sladen), July 20, 1924, on flowers of *Ceanathus Americanus*, (H. L. Viereck); Kazabazua, Que., July 3, 17, 1913; Saskatoon, Sask., July 25, 1923, 16410, 3N. 7C., (K. M. King).

Panurgidae

Panurginus aestivalis Prov. Toronto, Ont., Sept. 1, 1893; Hemmingford, Que., August 29, 30, 1916, (J. I. Beaulne); St. John, N.B., Aug. 6,1900, Aug. 9, 1903, Aug. 10, 1902, (A. G. Leavitt).

Calliopsis andreniformis Sm. Ottawa, Ont., June 28, July 29, 1913, (F. W. L. Sladen); June 26, 1914, (J. I. Beaulne); Lanoraie, Que., June 20, 1915, (J. I. Beaulne); Hull, Que., July 6, 1920, (G. Beaulieu); St. John, N.B., Aug. 9, 1902, (A. G. Leavitt); Dalhousie, N.B., July 24, 1915, (F. W. L. Sladen).

Panurgidae

Greeleyella beardsleyi Ckll. Lethbridge, Alta., July 7, 1909, (J. B. Wallis), July 11, 1922, (W. Carter).

Nomada (Gnathias) bella Cress. var. Agassiz, B.C., May 11, 1915, (F. W.L. Sladen); May 20, 1921, (R. Glendenning); Ft. Steel, B.C., June 20, 1922, (W. B. Anderson); Gabriola Island, B.C., (Taylor); Cranbrook, B.C., May 14, 1922, (C. B. D. Garrett); Chase, B.C., June 9, 1920, (W. B. Anderson); Victoria, B.C., May 29, 1916, (R. C. Treherne); Vernon, B.C., May 24, 1918, (W. Downes); Penticton, June 21, 1919, (E. R. Buckell).

Nomada (Gnathias) cuneata Rob. var. *quadrisignata* Rob. Kentville, N.S., June 22, 1914, (C.A.G.).

Nomada (Gnathias) ovata Rob. Ottawa, Ont., June 12, 1913, April 24, 1915, April 26, 1916, (F. W. L. Sladen); Toronto, Ont., May 31, 1895, May 17, 1896, 1897, June 8, 1888.

Nomada (Gnathias) albofasciata Sm. Chilcotin, B.C., May 2, 1901, (E. R. Buckell).

Nomada (Gnathias) grayi eastonensis Ckll. Agassiz, B.C., May 11, 1915, (F. W. L. Sladen).

Nomada (Nomada) ultima Ckll. Saanich Dist., June 2, 1918, (W. Downes).

Nomada (Nomada) illinoensis Rob. Ottawa, Ont., June 30, 1913; Cheticamp, C.B.I., June, July, 1917, (F. Johansen); Eastern Passage, N.S., July 5, 1914.

Nomada (Phor.) proxima Cress. Winnipeg, Man., Aug. 16, 1900, Winnipeg Beach, Man., July 17, 1916, (F. W. L. Sladen); Vernon, B.C., July 24, 1917, (F. W. L. Sladen); Lethbridge, Alta., July 28, 1916, (F. W. L. Sladen).

Phileremulus mallochi Cwfd. Medicine Hat, Alta., July 20, 1916, (F. W. L. Sladen).

Euceridae

Melissodes vernonensis Vier. Similkameen, Okanagan, B.C., Sept. 11, 12, 1913, (T. Wilson); Walhachin, B.C., June 27, 1918, (E. R. Buckell).

Tetralomia dilecta Cress. St. Mary River, Alta., July 20, 1923, (R. D. Bird).

Anthophoridae

Anthophora (Anthemoessa) gorhmanae Ckll. Nakusp, B.C., August 3, 1916, (F. W. L. Sladen); Kaslo, B.C., June 11, 1905, (J. W. Cockle).

Stelididae

Stelis (Microstelis) lateralis Cress. Ottawa, Ont., June 5, 17, 21, Aug. 5. 1913, (F. W. L. Sladen); Toronto, Ont., June 24, 1894, Sept. 23, 1891; Aylmer, Que., June 6, 1915, Potentilla; Kazabazua, Que., Aug. 9, 1913; Kirk's Ferry, Que., July 13, 1915, (F. W. L. Sladen); St. Anne's, Que., July 15, 1917; Hull, Que., July 6, 1920, (G. Beaulieu); Winnipeg, Man., April 1, 1920.

Megachilidae

Ashmeadiella denticulata Cress. Vernon, B.C., July 11, 1914, Spillemachine, July 3, 1914, (F. W. L. Sladen).

Andronicus cylindricus Cress. Toronto, Ont., August 12, 1887, June 4, 1883; Port Sydney, Ont., May 2, 1891; New Brunswick, July 26, 1902, (A. G. Leavitt); Dalhousie, N.B., July 24, 1915, (F. W. L. Sladen); Ironsides, Que., June 6, 1914, Rubus, (F. W. L. Sladen); Aylmer, Que., June 21, 1915; Hull, Que., June 14, 1914, May 28, 1915; Kazabazua, July 3, 13, Aug. 4, 1913; St. Ann de la Pocatiere, Que., Aug. 7, 1914; Maniwaki, Que., Aug., 1915; Quebec City, Aug. 8, 1914; Aweme, Man., July 24, 1914, (N. Criddle); Fort Wrigley, McKenzie River, July 25, 1922, (C. H. Crickmay); Painsec, N.S., Aug. 4, 1914; Kentville, N.S., July 30, 1914, (F. W. L. Sladen).

Monumetha argentifrons Cress. Toronto, Ont., Aug. 17, 1887; Sudbury, Ont., July 7, 1889; Ft. William, June 2, 1915, (F. W. L. Sladen); Ironsides, Que., June 6, 1914, (Rubus), (F. W. L. Sladen); Teulon, Man., Banff, Alta., Aug. 5, 1915, (Sanson); Upper Stewart River, N.W.T., 1905, (Jos. Keela); Shawnigan, V.I., B.C., June 7, 1914, (F. W. L. Sladen); Kaslo, B.C., May 24, Bulkley Valley, June 14, 1914, (Tom Wilson); Invermere, B.C., June 30, 1914, (F. W. L. Sladen); Vernon, B.C., June 25, 1917, (F. W. L. Sladen); Illicilliwaet, B.C., June 11, 1885; Nicola Lake, B.C., May 27, 1922, (E. R. Buckell); Penticton, B.C., June 29, 1919, (E. R. Buckell); Lytton, B.C., June, 1913, (Tom Wilson); Peachland, B.C., June 31, 1909, (J. B. Wallis); Fort Simpson, McKenzie River, June 25, 1922, (C. H. Crickmay).

Megachile grindelearum Ckll. Peachland, B.C., Aug. 2, 1909 (J. B. Wallis).

Megachile giliae Ckll. Banff, July 2, 1906 (Sanson).

Apidae

Bremus borealis Kby. Ottawa, Ont., June 10, 13, 1913, (F. W. L. Sladen); Nipigon, Ont., (J. Fletcher); Perce, Que., June 28, 1884, (C. H. Young); Montreal, Que., Sept. 1, 1906; Kazabazua, Que., Aug. 4, 1913, (F. W. L. Sladen); East Coast, James Bay, July, 1920, (F. Johansen); Truro, N.S., July 29, 1913; Dalhousie, N.B., July 24, 1915, (F. W. L. Sladen); Newfoundland; Hampton, P.E.I., Aug. 20, 1909, (A. Gibson); Rosthern, Sask., July 17, 1914, (F. W. L. Sladen); Winnipeg, Man., June 10, 1900, (J. B. Wallis); Spirit R., Aug. 20, 1915, (E. H. Strickland); Millarville, Alta., August 2, 1904.

Bremus kincaidi Ckll. Winter Ft., Melville I., July 20, 1909, (F. C. Hennessey).
Bremus silvicola johanseni Sladen. For data see Report of the Canadian Arctic Expedition, 1913-18, Vol. III: Insects, Part G, Hymenoptera and Plant Galls.
Bremus pleuralis Nyl. For data see Report of the Canadian Arctic Expedition, 1913-18, Vol. III: Insects, Part G, Hymenoptera and Plant Galls.
Bremus flavifrons var. *dimidiatus* Ashm. East Coast, James Bay, July, 1920, (F. Johansen); Banff, Alta., July 20, 1922, (C.B.D. Garrett); Hazelton, B.C., July 26, 1920, (C. M. Barbeau).

Hemiptera

Gerridae

* *Gerris insperatus* D. & H. Ottawa, Ont., (Miss Beaulieu); Hogs Back, Ont., (Ozburn); Abitibi, Que., (Dr. Cook).
* *Gerris incurvatus* D & H. Saanich, B.C., (Downes); Kaslo, B.C., (Currie).
Gerris incognitus D & H. Kaslo, B.C., (Currie); Goldstream, B.C., (Auden).

The above species described in "Proc. Biol. Soc. Wash.," Vol. 28, May, 1925.

Ephemeroptera

Baetidae

* *Ephemerella funeralis* McD. Covey Hill, Que., June, (G. S. Walley).
* *Ephemerella fratercula* McD. Covey Hill, Que., June, (Walley).
* *Baetis cingulatus* McD. Covey Hill, Que., June, (Walley and Curran).
* *Baetis levitans* McD. Covey Hill, Que., (Curran & Walley).
* *Baetis rusticans* McD. Covey Hill, Que., June, (Walley & Curran).
* *Baetis pluto* McD. Covey Hill, Que., (Walley); Broadview, Que., (R. Ozburn).
* *Baetis vagans* McD. Covey Hill, Que., June, (Curran & Walley).
* *Baetis incertans* McD. Covey Hill, Que., July, (Walley).
The above species described in "Trans. Royal Soc. Can.", 3rd Series, Vol. XIX, 1925.

Orthoptera

Grylloblattidae

Grylloblatta campodeiformis Walk. Toby Creek, Invermere, B.C., 7,300 ft., August, (E. R. Buckell).

Labiduridae

Anisolabis maritima Gene. Snake Island, Departure Bay, B.C., May, (G. J. Spencer).

Acrididae

Bradynotes caurus Scudd. Rockcreek, B.C., (Buckell). Previously recorded as *B. pinguis* Scud.
Asemoplus hespidus Brun. Invermere, B.C., Aug., (Buckell).
Melanoplus dawsoni Scud. Canal Flats, B.C., Aug., (Buckell).
Melanoplus stonii Hebd. Victoria Beach, Man., Aug., Sept., (Wallis and Criddle).

Tettigoniidae

Anabrus simplex Held. Cranbrook, B.C., Aug., (Buckell).

INDEX

	Page
Aedes argenteus	62
" *hursuteron*	8
" *stimulans*	8
" *vexans*	8
Agriolimax agrestis	8
Alabama argillacea	44
Altica chalybea	14
Alypia octomaculata	11
American tent caterpillars	65
Anarsia lineatella	14
Anasa tristis	12
Anisota senatoria	16
Anomola orientalis	61
Anopheles sp	62
Anthonomus signatus	15
Ants	17
Anuraphis roseus	13
Aonidia lauri	54
Apanteles lacteicolor	64
Aphidae	10
Aphids	10
Aphids—Gall-producing	9
Aphis brassicae	16
" *illinoisensis*	15
" *pomi*	13, 36
" *rumicis*	37
Apple Aphids	13, 43
" leafhoppers	13
" maggot	13
" and thorn skeletonizer	60
Archips argyrspila	13
Asiatic beetle	61
Asilus snowi	90
Aspidiotus perniciosus	13
Aulacaspis rosae	19
Barathra occidentata	48, 50
Bark Beetle	53, 54
Basilona imperialis	8
Bedbugs	17, 35
Beet leaf miner	15
Birch leaf skeletonizer	49, 69
Black Aphids	46
Black army cutworm	16
Blackberry leaf miner	15
Black cherry aphids	43
Boletobius dimidiatus	46
Braconids	65
Broad bean weevil	52
Brown grape aphis	15
Brown tail moth	60, 63
Bucculatrix canadensisella	49, 69
Bud moth	11, 13, 35
Buprested Beetles	54
Cabbage aphis	16
" maggott	8, 11
" root maggot	83
" worm	8, 12, 48
" webworm	51
Cacoecia cerasivorana	91
Calosoma sycophanta	65
Carpet beetles	17
Carpocapsa pomonella	11, 51
Carrot rust fly	7, 16, 35, 48
Cattle lice	40
Cerambycid beetles	53

	Page
Cercopid sp	12
Chermes	39
Cherry slug	11
Chloridea obsoleta	16
Cholomyia inaequipes	46
Cicadula sex-notata	84
Cigar and pistol case bearer	14
Cigarette beetle	53
Cimex lectularius	35
Citrus insects	43
Clover leaf curculio	79
" " weevil	17
" root borer	92
Clothes moths	17, 35
Codling moth	11, 13, 51
Coleoptera	46
Colorado potato beetle	7, 27
Compsilura cincinnata	64
Conotrachelus nenuphar	11
Cooties	62
Corn ear worm	11, 16, 49
Corn root maggot	83
Cotton moth	44
Cottony maple scale	43
Crioceris 12-punctata	7
Cucujid beetles	54
Cucumber beetles	12, 15
Currant aphis	39, 49
" worm	11
Cutworms	7, 12, 16, 39, 48, 83
Cydia pomonella	13
Danaus archippus	44
Dark-brown aphis	49
Datana ministra	12, 49
Depressaria heracliana	11
Dermestes sp	53
Diabrotica 12-punctata	12, 15
" *vittata*	12, 15, 48, 80
Dilachnus piceae	46
Dorydiella floridana	46
Earthworms	40
Egg parasites	78
Eight spotted foresters	11
Elm scale	10, 43
" bark louse	10
Empoasca fabae	13
" *mali*	11, 84
Enochrus consorns	46
Ephestia cantella	50
" *kuehniella*	50
Epitrix eucumeris	84
Eriocampoides limacina	11, 14
Eros sculptilis	46
Erythroneura comes	15
" *tricineta*	15
European corn borer	11, 12, 15, 60, 72, 75, 78
" pine shoot moth	71
" red mite	13, 43
Exeristes roborator	78
Fall webworm	12, 14, 35
Fenusa pumila	61
Fig moth	50
Flat-headed borer	54
Flea beetle	12
Flower fly	46

	Page
Forest tent caterpillars	32, 65
Four-lined plant bug	8
Fruit lecanium	43
Fruit tree leaf roller	13, 43
Gall makers	10
Geometrid larvae	39
Gracilaria cuculipenellum	8
" *syringella*	8, 16
Grain mite	17
Grape berry moth	15, 17
" leafhopper	15
" plume moth	15
Grapevine flea beetle	14
Graptolitha antennata	8
Grasshoppers	83
Grass spittle insects	12
Green aphids	84
" apple aphids	36
" fruit worm	8
" house scales	43
" peach aphis	14
Gryllus domesticus	17
Gypsy moth	60, 67
Habrobracon brevicornis	78
Heliothis obsoleta	11, 49
Hellula undalis	51
Helochara communis	84
Hemerocampa definita	49
" *leucostigma*	14, 49
Hemerophila pariana	60
Hessian fly	12
Horn fly	12
House cricket	17
" fly	34, 62
Household pests	17
Humped apple caterpillar	11
Hydrotaea houghi	86
Hylastinus obscurus	92
Hylemyia antigna	7, 15
" *brassicae*	8
Hypera punctata	17
Hyphantria cunea	14, 35
" *textor*	49
" *sp*	12
Hypoderma bovis	12
Imperial moth (larva)	8
Imported cabbage worm	38
" currant worm	33
Indian meal moth	51
Japanese beetle	60
June beetle	12
Lace winged flies	47
Ladybird beetle larvae	39
Langurea augustata	53
Larch case bearer	39
Larch sawfly	39
Larder (?) beetle	53
Lasioderma serricorne	53
Laspeyresia molesta	14, 22, 60
Leafhoppers	84
Leaf miner	10
Lecanium corni	14
" fruit scale	14
Lema trilineata	8, 12
Lepidosaphes ulmi	54
Leptinotarsa decemlineata	7, 12, 27
Lilac leaf miner	8, 16
Longitarsus turbatus	46
Lyctus sp	16
Lygus caryae	14
" *omnivagus*	14
Lygus pratensis	8, 14, 84
" *quercalbae*	14
Macrodactylus subspinosus	11, 15
Macrosiphum rudbekiae	50
Macrosiphum pisi	48, 84
" *solanifolii*	37
Malacosoma americana	32
" *disstria*	32
Maple leaf cutter	8, 49
Mediterranean flour moth	50
Metallus bethunei	15
Mexican dexid	46
Microphthalma michiganensis	85, 89
" *phyelophagae*	89
Midges	47
Miridae	14
Monarch butterfly	44
Monophadnoides rubi	15
Monophadnus rubi	11
Mosquitoes	8, 62
Mosquito larvae	40
Musca domestica	34
Myelois ceratoniae	51
Mylabris pesorum	52
" *rufimanus*	52
" *sp*	52
Myzus persicae	14
" *ribis*	49
Neodiprion lecontei	8
Noctua fennica	16
Noctuids	50
Oak and hickory plant bug	14
Onion maggot	7, 11, 15, 43, 48, 83
" thrip	11
Orchards aphids	43
" tent caterpillars	32
Oriental peach moth	14, 22, 60
Oyster shell scale	43, 54
Oxyporus bicolor	46
Oxyptilus periscelidactylus	15
Painted lady butterflies	45
Paleacrita vernata	8, 13
Papillia japonica	60
Papaepema cataphracta	11, 16
Parabolocratus viridus	84
Paraclemensia acerifoliella	8, 49
Paratetranychus pilosus	13
Parsnip webworm	11
Pea louse	48
" weevil	52
Peach twig borer	14
Pear psylla	14, 40
" slug	14
Pelecinus polyturator	86
Pegomyia brassicae	83
" *fuscipes*	83
" *hyoscyami*	15, 48
Pemphegus bursarius	9
" *populicaulis*	9, 49
" *populi-transversus*	9
" *vagabundus*	9
Peridroma margaritosa	16
Phorbia brassicae	11
" *ceparium*	11, 48
" *cepetorum*	83
" *fuscipes*	48
Phycid larvae	52
Phyllophaga anxia	85
" *rugosa*	12
Phytophaga destructor	12
Pieris rapae	8, 12, 38

PAGE

Pine sawfly........ 8
Pin-hole borer........ 53
Plant bugs........ 14
" lice........ 10
Platypus sp........ 53
Plodia interpunctella........ 51
Plum curculio........ 11
Plume moths........ 47
Poecelocapsus lineatus........ 8
Polychrosis viteana........ 15
Potato aphis........ 37
" beetles........ 12, 48
" flea beetle........ 84
" leafhopper........ 11
" stalk borer........ 11
Powder post beetles........ 16
Privet leaf miner........ 8
Prodenia commelinae........ 51
Prospatella perniciosi........ 58
Psila rosae........ 7, 16, 35, 48
Psyllia pyri........ 14
Psyllidae........ 10
Pteronus ribesii........ 11, 33, 49
Putman scale........ 43
Pyrameis cardui........ 45
Pyrausta nubilalis........ 12, 15, 72
Pyrgota undata........ 86
Raspberry sawfly........ 11, 15
Red aphis........ 39
Red-banded leaf roller........ 43
Red bug........ 43
" humped oak or maple worm........ 16
" spiders........ 15
Rhagoletis pomonella........ 13
Rhizoglyphus phylloxerae........ 91
Rhyacionia buoliana........ 71
Rose beetle........ 11
" chafer........ 15
" leafhopper........ 13
" scale........ 19
Round-headed borers........ 53
Saperda candida........ 49
San José scale........ 13, 40, 43, 58
Satin moth........ 60
Sawfly leaf miner........ 61
Schizoneura lonigera........ 49

PAGE

Schizura concenna........ 11, 49
Scolia manilae........ 61
Sitones hispidulus........ 79
Slugs........ 8, 40
Snails........ 83
Spilonota ocellana........ 13, 35
Spinach leaf miner........ 48
Spiny oak worm........ 16
Spring canker worm........ 8, 13
Squash bug........ 12, 39
Stable flies........ 17
Stalk borer........ 16
Stem borer........ 53
Stomoxys calcitrans........ 17
Strawberry weevil........ 15
Striped cucumber beetle........ 80
Symmerista albifrons........ 16
Syrphid fly larvae........ 39
Syrphus ribesii........ 46
Tabanus septentrionalis........ 46
Tachnids........ 65
Tarnished plant bug........ 8, 14, 84
Tent caterpillars........ 10
Tetranychus telarius........ 15
Thamnotettix pallidulus........ 46
Three-lined potato beetle........ 8, 12, 39
Thrip tabaci........ 11
Tiphia inornata........ 85, 87, 90
Tmetocera ocellana........ 11
Trichogramma minutum........ 78
Tsetse flies........ 62
Tussock moth........ 10
Twelve spotted asparagus beetle........ 7
Typhlocyba rosae........ 13
Tyroglyphus armipes........ 91
" *farinae*........ 17
Vitula sp........ 52
Vanessa antiopa........ 49
Variegated cutworm........ 16
Walnut caterpillar........ 12
Warble fly........ 12
White grubs........ 85
White marked tussock moth........ 14
Wireworms........ 16, 83
Xyleborus sp........ 53
Zenillia caesar........ 78

Ontario Department of Agriculture

FIFTY-SEVENTH ANNUAL REPORT

OF THE

Entomological Society

of Ontario

1926

PRINTED BY ORDER OF

HON. J. S. MARTIN, Minister of Agriculture

ONTARIO

TORONTO
Printed by the Printer to the King's Most Excellent Majesty
1 9 2 7

PRODUCED BY
The
United Press
LIMITED
TORONTO
CANADA

CONTENTS

PAGE

Officers for 1926-1927 4

Financial Statement 4

Annual Meeting 5

Report of the Council 5

Report of the Montreal Branch 7

Report of the British Columbia Branch 7

Report of Insects for the year, Division No. 1: C. B. Hutchings 7

A Study of *Balinus obtusus* Blanchard; or, a Life History in a Hazel Nutshell: C. B. Hutchings 9

Mosquito Control at Ottawa, Ontario: C. R. Twinn 12

Paradichlorobenzene as a Control for the Mushroom Mite: L. Caesar 17

Notes Upon the Insect Preparations Used in Class Work at the Oka Institute of Agriculture: Rev. Father Leopold 19

The Activities of the Division of Foreign Pests Suppression: L. S. McLaine 20

Some Preliminary Observations on the Life History of the Armyworm, *Cirphis unipuncta* Haw.: H. F. Hudson and A. A. Wood 22

The Spread and Degree of Infestation of the European Corn Borer in Canada, 1926: W. N. Keenan 24

The Occurrence of the European Corn Borer in Ontario in Plants Other than Corn and its Significance: J. Marshall 28

The Larval Mortality of the European Corn Borer in 1926: James Marshall 33

The European Corn Borer—The Outlook in Ontario: L. Caesar 35

The Currant Fruit Fly, *Epochra canadensis* Loew, in Manitoba, Diptera, Trypetidae: A. V. Mitchener 38

An Outbreak of the Turnip Aphid (*Aphis pseudobrassicae* Davis): L. Caesar 41

Some Notes on the Oviposition Habits of the Tarnished Plant Bug, *Lygus pratensis* Linn, with a List of Host Plants: R. H. Painter 44

The Entomological Record, 1926: Norman Criddle 47

Index 63

Entomological Society of Ontario

OFFICERS FOR 1926-1927

President—Rev. Father Leopold, La Trappe, Que.

Vice-President—Prof. A. W. Baker, B.S.A., O. A. College, Guelph.

Secretary-Treasurer—R. Ozburn, O. A. College, Guelph.

Curator and Librarian—Miss Rose King, O. A. College, Guelph.

Directors—Division No. 1, C. B. Hutchings, Entomological Branch, Dept. of Agriculture, Ottawa; Division No. 2, C E. Grant, Orillia; Division No. 3, Dr. Norma Ford, Univ. of Toronto; Division No. 4, F. J. A. Morris, Peterborough; Division No 5, Dr J. D. Detwiler, Western University, London; Division No. 6, H. F. Hudson, Strathroy; Division No. 7, W. A. Ross, Vineland Station.

Dire tors (ex-Presidents of the Society)—Rev. Prof. C. J. S. Bethune, Toronto; Prof. John Dearness, London; Prof. Wm. Lochhead, Macdonald College, Que.; John D. Evans, Trenton; Prof. E. M. Walker, University of Toronto; Albert F. Winn, Westmount, Que.; Prof. Lawson Caesar, O. A. College, Guelph; Arthur Gibson, Dominion Entomologist, Ottawa; Mr. F. J. A. Morris, Peterborough; Dr. J. H. Swaine, Entomological Branch, Ottawa.

Editor of "The Canadian Entomologist"—Dr. J. McDunnough, Entomological Bianch, Ottawa.

Delegate to the Royal Society of Canada—The President.

FINANCIAL STATEMENT

For the Year Ending October 31st, 1926

Receipts		*Expenditures*	
Cash on hand, 1925	$468 27	Printing	$1,410 00
Subscriptions	525 45	Salaries and honoraria	250 00
Members' dues	176 45	Expense	52 23
Advertisements	79 00	Annual meeting	109 37
Back numbers	61 69	Cuts	19 70
Bank Interest	7 89	Exchange	16 54
Annual meeting	1 33	Balance cash on hand	462 24
Government grant	1,000 00		
	$2,320 08		$2,320 08

By cash on hand	462 24
To printing account payable	115 00
Net balance	$347 24

Respectfully submitted,

Reg. H. Ozburn,
Secretary-Treasurer.

Entomological Society of Ontario

ANNUAL MEETING

The sixty-third annual meeting of the Entomological Society of Ontario was held at the Ontario Agricultural College, Guelph, Tuesday and Wednesday, November 16th and 17th, 1926.

The morning and afternoon meetings were held in the Entomological lecture room, Biological Building. The smoker on Tuesday evening was held in the Faculty Club Room, in Memorial Hall.

REPORT OF THE COUNCIL

The Council of the Entomological Society of Ontario begs to present its report for the year 1925-26.

The sixty-second annual meeting of the Society was held in Ottawa on Friday and Saturday, November 27th and 28th, 1925.

The meeting was very well attended by members of the Society from various provinces and by a large number of visitors.

The morning and afternoon meetings were held in the exhibition room of the Entomological Branch. The Friday evening meeting was held in the Assembly Hall of the Normal School when Dr. J. H. Grisdale acted as chairman and Dr. W. E. Britton, State Entomologist of Connecticut, delivered the public lecture on "Some Insects and Entomologists." A moving picture film showing "Depredations by the European Corn-borer" was then shown. After this meeting a smoker was held at the University Club, the freedom of which had been extended to the members.

The programme was full and interesting.

"Insects of the Season in Ontario" (by title)—Messrs. L. Caesar, Guelph, Ont., and W. A. Ross, Vineland Station, Ont.

"Insects of the Season, District No. 1, Ottawa" (by title)—Mr. C. B. Hutchings, Entomological Branch, Ottawa.

"Insects of Quebec" (10 minutes)—Rev. Father Leopold, La Trappe, Que.

"The Control of the Grape Berry Moth" (10 minutes)—Mr. W. A. Ross, Entomological Branch, Vineland Station, Ont.

"The Rose Scale in British Columbia" (10 minutes)—Mr. W. Downes, Entomological Branch, Victoria, B.C.

"The Oriental Peach Moth in Canada" (10 minutes)—Mr. Arthur Gibson, Entomological Branch, Ottawa.

"Derris as an Insecticide" (15 minutes)—Messrs. A. Kelsall, J. P. Spittal, R. P. Gorham and G. P. Walker, Entomological Branch, Annapolis, N.S.

"Lubricating Oil Sprays" (10 minutes)—Mr. W. A. Ross, Entomological Branch, Vineland Station, Ont.

"Some Impressions Entomological and Otherwise in Relation to Prince Edward Island Agriculture" (10 minutes)—Mr. A. G. Dustan, Entomological Branch, Ottawa.

"Record of an Earwig New to Canada" (6 minutes)—Prof. G. J. Spencer, University of B.C., Vancouver, B.C.

"Notes on Mosquitoes in the Ottawa District, Ont." (8 minutes)—Mr. C. R. Twinn, Entomological Branch, Ottawa.

"A Preliminary Revision of some Charopsinae, a subfamily of Ichneumonoidea or Ichneumon Flies" (by title)—Mr. H. L. Viereck, Entomological Branch, Ottawa.

"The Identification of Adult Lepidopterous Insects Attacking Stored Products" (10 minutes) —Mr. C. H. Curran, Entomological Branch, Ottawa.

"Variation in Heredity in *Bruchus quadrimaculatus* Fabr." (15 minutes)—Dr. J. K. Breitenbecatr, McGill University, Montreal.

"The Distribution of Insects and the Significance of Extralimital Data" (15 minutes)—Dr. E. P. Felt, State Entomologist, Albany, N.Y.
"Birds from an Entomologist's Point of View" (10 minutes)—Mr. Norman Criddle, Entomological Branch, Treebank, Man.
"Some Problems in the Anatomy and Physiology of *Grylloblatta*" (30 minutes)—Dr. E. M. Walker and Dr. Norma Ford, University of Toronto, Toronto, Ont.
"The Canadian National Collection of Insects" (10 minutes)—Dr. J. H. McDunnough, Entomological Branch, Ottawa.
"Methods of Measuring Light in Field and Experimental Entomology" (5 minutes)—Mr. A. Brooker Klugh, Queen's University, Kingston.
"The Distribution in Canada of a European Scavenger Fly, *Muscina pascuorum* Meig (5 minutes)—Mr. C. H. Curran, Entomological Branch, Ottawa.
"A Needed Revision in Relation to Generic Names" (10 minutes)—Dr. E. P. Felt, State Entomologist, Albany, N.Y.
"Observations in Quebec in 1925" (10 minutes)—Mr. George Maheux, Provincial Entomologist, Quebec, Que.
"Some Insects found on Imported Plant Products entering Canada by Rail and Road" (8 minutes)—Mr. R. W. Sheppard, Entomological Branch, Niagara Falls.
"Controlling the Brown-tail Moth in Nova Scotia" (8 minutes)—Mr. F. C. Gilliatt, Entomological Branch, Annapolis, N.S.
"The Gypsy Moth Situation in Quebec" (8 minutes)—Messrs. L. S. McLaine and S. H. Short, Entomological Branch, Ottawa.
"Progress of the Gypsy Moth Barrier Zone Work" (15 minutes)—Mr. H. L. McIntyre, in charge of Gypsy Moth Work, Conservation Commission, Albany, N.Y.
"Insects Affecting Shade Trees on the Prairies" (8 minutes)—Mr. J. J. de Gryse, Entomological Branch, Ottawa.
"Some Notes on *Bucculatrix canadensisella* Chamb." (5 minutes)—Mr. C. B. Hutchings, Entomological Branch, Ottawa.
"Forést Insect Conditions in Newfoundland" (10 minutes)—Dr. J. M. Swaine, Entomological Branch, Ottawa.
"Notes on the Yellow Striped Oak Caterpillar, *Anisota senatoria* A. & S." (5 minutes)—Mr. Arthur Gibson, Entomological Branch, Ottawa.
"A Preliminary Announcement on the Outbreak of the European Pine Shoot Moth" (5 minutes)—Mr. L. S. McLaine, Entomological Branch, Ottawa.
"Environmental Studies Relative to the Overwintering Mortality and Rate of Pupation and Emergence of the European Corn Borer Larva" (10 minutes)—Mr. G. A. Ficht, University of Western Ontario, London, Ont.
"Mortality of the European Corn Borer Adults and Larvae" (10 minutes)—Mr. Lawson Caesar, O.A.C. Guelph, Ontario.
"The Spread and Degree of Infestation of the European Corn Borer in Ontario in 1925" (8 minutes)—Mr. W. S. Keenan, Entomological Branch, Ottawa.
"An Appraisal of the European Corn Borer Investigations as Carried on by the Entolomogical Branch" (8 minutes)—Mr. H. G. Crawford, Entomological Branch, Ottawa.
"Weed Infestation by the European Corn Borer" (5 minutes)—Messrs. L. Caesar and James Marshall, O.A.C., Guelph.
"Recent Developments in the Introduction of Parasites of the European Corn Borer" (8 minutes)—Mr. A. B. Baird, Entomological Branch, Chatham, Ontario.
"Studies of the Clover Leaf Curculio" (5 minutes)—Mr. H. F. Hudson, Entomological Branch, Strathroy, Ontario.
"The Striped Cucumber Beetle, *Diabrotica vittata* Fabr." (8 minutes)—Mr. James Marshall, O.A.C., Guelph.
"The Garden Insects of 1925 with Special Reference to the Celery Leaf Hopper" (10 minutes)—Mr. Lionel Daviault, Macdonald College, Que.
"Parasites of the White Grubs and June Beetles in the Hemmingford District" (10 minutes)—Mr. G. H. Hammond, Entomological Branch, Hemmingford, Que.
"Notes on *Calligrapha elegans*" (5 minutes)—Mr. R. M. White, Entomological Branch, Treesbank, Man.
"Notes on the Life-history of the Clover Root Borer" (5 minutes)—Mr. H. F. Hudson, Entomological Branch, Strathroy.
"The Saskatoon Sawfly, *Hoplocampa halcyon* Norton" (5 minutes)—Mr. R. D. Bird, Entomological Branch, Treesbank, Man.

The Canadian Entomologist, the official organ of the Society, completed its fifty-seventh volume in December last. This volume contained 312 pages, illustrated by eight full page plates and twenty-two text figures. The contributors to its pages numbered forty-four, and included writers in British Columbia, Alberta, Manitoba, Ontario, Quebec, Honolulu, France, and thirteen of the United States.

REPORT OF THE MONTREAL BRANCH

The fifty-third annual meeting of this Branch was held on May 15th, 1926, in the Lyman Entomological Room, McGill University.

Eight meetings were held during the season in the Lyman Entomological Room and residences of members, with an average attendance of seven.

The following papers were read during the year:

"Classification"	Geo. A. Moore.
"Entomological Notes"	Geo. A. Moore.
"Insects Collected at Peake's Island, Maine"	Geo. A. Moore.
"Two Interesting Wasps"	J. W. Buckle.
"Insects Taken at Lac L'Achigan"	A. F. Winn.
"Hemiptera of Peake's Island"	G. A. Moore.
"Aquatic and Semi-aquatic Hemiptera"	G. A. Moore.
"The So-called Auditory Organs of Insects"	A. F. Winn.
"Genetics of Bruchus"	Dr. J. K. Breitenbecker.
"Ground Bugs" (Geocoridae)	Geo. A. Moore.

The following were elected officers: President, Geo. A. Moore; vice-president, G. H. Hall; secretary-treasurer, J. W. Buckle; council—G. Chagnon, A. C. Sheppard, A. G. Winn and G. Fisk.

J. W. Buckle, *Secretary.*

REPORT OF THE BRITISH COLUMBIA BRANCH

The twenty-fifth annual meeting was held in the Empress Hotel, Victoria, B.C., on February 27th, 1926.

The following papers were read:

"Presidential Address"	L. E. Marmont.
"Observations on Some Insects Collected in British Columbia"	O. Whittaker.
"Notes on the European Earwig in Vancouver"	J. Stanley.
"Recent Methods in the Control of the Strawberry Root Weevil"	W. Downes.
"Some Blood-sucking Flies of British Columbia"	E. Hearle.
"Recent Records of Insects of Veterinary Interest"	E. A. Bruce, V.S.
"Leaf-roller Parasites in the Okanagan Valley"	E. P. Venables.
"Insect Studies"	G. J. Spencer.
"Some Ants and Their Habits"	E. R. Buckell.
"On the Life History of the Hop-plum Aphis"	R. Glendenning.

Five new members were elected and the financial statement showed a credit balance of $194.25.

The election of officers resulted as follows: Honorary president, F. Kermode; president, J. W. Winson; vice-president (coast), G. J. Spencer; vice-president (interior), E. R. Buckell; advisory board, Messrs. Downes, Hardy, Lyne, Venables and Whittaker; secretary-treasurer, W. Glendenning, Agassiz, B.C.

REPORT OF INSECTS FOR THE YEAR 1926

Division No. 1, Ottawa District—C. B. Hutchings

The following more important insects were reported during the past season, 1926.

Field, Crop, and Garden Insects

The European Corn Borer, *Pyrausta nubilalis*, Hubn., has spread eastwards into Quebec Province,being found this past summer in the Townships of Eardley, Hull and Templeton, Quebec, adjacent to the Province of Ontario, and in

Carleton and Russell Counties, Ontario. The infestation is reported to be light.

Injury by the Imported Cabbage Worm, *Pieris rapae* L., was very marked in fields around Billings Bridge, Ontario and at Aylmer, Quebec.

Turnip foliage was injured very severely by larvae of the Diamond-back moth, *Plutella maculipennis* Curt., over 50 per cent. of the leaves being attacked.

The Four-lined Plant Bug, *Poecilocapsus lineatus* Fab., was particularly abundant in July and caused loss in gardens around Ottawa. It was considered one of the most destructive insects of the year and its excessive foliage-feeding on a wide variety of plants caused many complaints.

Grasshoppers. The fields around Aylmer district this fall were infested with swarms of grasshoppers. *Melanoplus bivittatus* Say., and *M. femur-rubrum* DeG., were chiefly in evidence.

The Raspberry Cane Borer, *Oberea bimaculata* Oliv., was reported from many areas as being particularly numerous and injurious and many inquiries were received as to its control.

The Onion Maggot, *Hylemyia antiqua* Meig., was abundant generally and did much damage, but was more severe in the district of Aylmer than other localities.

Colorado Potato Beetle, *Leptinotarsa decemlineata* Say., was numerous in all potato fields and accounted for much loss by severe defoliation.

There were many complaints received from gardeners concerning borers in Columbine and Iris. The former insect was very abundant at the Central Experimental Farm while the latter was found in suburban nurseries.

Wherever parsnips were grown for seed, the Parsnip Webworm, *Depressaria heracliana* DeG., was numerous. This was particularly the case at the Central Experimental Farm where considerable loss was accounted for.

Tarnished Plant Bug, *Lygus pratensis* L., was much more numerous than last year and on a wide range of crops, though there appears to have been no special injury credited to this insect.

Cabbage Maggot, *Hylemyia brassicae* Bouche, was present in a large number of gardens and caused much loss.

Slugs were exceedingly numerous in August at the Central Experimental Farm and southern parts of Ottawa. Garden vegetables such as tomatoes and cabbages showed 100 per cent. infestation.

Shade Tree Insects

The Maple Leaf Cutter, *Paraclemensia acerifoliella* Fitch, was fairly abundant on maples in Ottawa City and the surrounding districts this past summer. It was noticed to be decidedly on the increase.

Tent Caterpillars, *Malacosoma americana* Fab. and *M. disstria* Hb., were abundant in June on apple, chokecherry and other hosts. They were particularly numerous in the districts surrounding Aylmer.

The larvae of a sawfly (species unidentified) defoliated viburnums in the Gatineau Point District, Quebec, during midsummer.

The Spring Cankerworm, *Paleacrita vernata* Peck, was abundant on soft maples, elm, ash and other hardwoods in the Gatineau and Rockcliffe districts.

Many complaints were received during late summer concerning the disfigurement of lilac bushes by caterpillars of the Lilac Leaf Miner, *Gracilaria syringella* Fab.

During the latter part of September, wild plums, *Prunus nigra*, in different districts about Ottawa were completely stripped of their foliage by the larvae of an unidentified species of sawfly.

Miscellaneous

Mosquitoes were particularly troublesome in Rockcliffe, northern sections of Ottawa, and outlying villages during spring and early summer. This was due to a heavy migration of mosquitoes from the Gatineau Point and Kettle Island flood water areas, the mosquitoes being carried by the prevailing winds across the Ottawa River. The species concerned in this connection was *Aedes hirsuteron* Theo. During the latter part of July, *Aedes vexans* Mgn., was numerous in the west sections of Ottawa.

During April and May the adults of the Webbing Clothes Moth, *Tineola biselliella* Hum., were quite numerous in Ottawa houses. The Case-making Clothes Moth, *Tinea pellionella* L., was also taken.

House flies, *Musca domestica* A., were more abundant this summer in Ottawa than for several years past. From midsummer until late fall they proved troublesome.

During September and October, the Cat Flea, *Ctenocephalus felis* Bouche, was present in a number of houses in Ottawa and caused considerable annoyance in its attacks upon human beings.

A STUDY OF *BALANINUS OBTUSUS* BLANCHARD; OR, A LIFE HISTORY IN A HAZEL NUTSHELL

C. B. Hutchings, Entomological Branch, Ottawa.

There are a number of species of the weevil group which attack the fruit of nut-producing trees, and which are of considerable economic importance. Many of these belong to the genus *Balaninus*. For example—*Balaninus quercus* Horn feeds on the acorns of red and black oak; *B. caryae* Horn infests hickory nuts; *B. rectus* Say and *B. proboscidus* Fab., both are considered serious enemies of chestnuts. Still another member of this genus is *B. obtusus* Blanch, which chooses the fruit of the hazel for its food, and as a consequence causes a great deal of injury and loss in output of this popular table dessert. In view of the comparatively recent development of the nut-growing industry in Ontario and British Columbia, this last mentioned species becomes one of special importance economically and worthy of some consideration.

Nut growing in Canada in the past has been somewhat neglected, but is now receiving considerable attention, particularly in the Niagara Peninsula, Western Ontario and British Columbia. Walnuts, hickories, hazels and other varieties are being grown successfully with increasing returns and good profits.

The Ontario Department of Agriculture, recognizing the possibilities of such an industry, and with the purpose of assisting the present growers as well as encouraging others to take up this business, have already done a great deal of experimental work in crossing varieties, in cultural methods and in determining the best growing areas. It is very gratifying to learn that considerable success has already attended these efforts.

The hazel is one of the varieties that has received some attention. It is considered one of the hardiest and easiest grown of our nut producing trees. Not only does it thrive in the Niagara belt and other sections of Ontario, but is found growing as far north as Hudson Bay and in the Peace River District. A number of introduced varieties of filberts and cobnuts, from England and Southern Europe, have done well in different parts of Ontario and the results have proved encouraging.

This work has been under the direct management of Mr. Jas. A. Neilson, horticulturist at Vineland Station, who is quite an enthusiast. Those who have seen the interesting exhibition of nuts at the Royal Winter Fair, Toronto, for the past two seasons must have been favourably impressed and surprised to learn of the large number of varieties of nuts that could be grown in Canada, and the size and quality of the different kinds.

The following figures, supplied by the Department of Customs and Excise, show the amounts and value of nuts imported into Canada for the years 1923, 1924 and 1925 from various countries.

It will be seen that hazelnuts represent on an average of 10 per cent. of the bulk imported for the three years mentioned.

Nut Imports*	1923		1924		1925	
	lbs.	$	lbs.	$	lbs.	$
Unshelled	6,745,662	723,141	6,689,984	670,879	5,218,004	581,214
Shelled	5,646,286	1,681,769	7,363,951	1,649,115	7,180,369	2,207,051
Total	12,391,948	2,407,910	14,062,935	2,319,994	12,398,373	2,788,265
Of which were hazelnuts	1,382,027	113,702	1,514,008	84,871	957,580	95,835

LIFE HISTORY AND HABITS: An opportunity of studying *B. obtusus* Blanch occurred during the summers of 1924 and 1925. A number of bushes of *Corylus rostrata* Ait., the beaked hazel, growing near the Dominion Entomological Field Station at Aylmer, Que., were found badly attacked by this weevil. A series of observations on its life history and habits were made and some adults collected for study. This work was done in co-operation with Mr. C. E. Yauch, my summer assistant, for whose help in this connection I am obliged.

It was observed that during the early days of June the weevils were to be found often in pairs, resting on the old flower heads or leisurely walking over the bracts nearby. They were very shy and had to be approached cautiously, otherwise, at the least jarring of the foliage, or sudden appearance of a hand over them, they would instantly feign death, roll off the leaf and fall to the ground where they would be lost to view among the dead leaves. If, however, the observer approached slowly, he could get near enough to see the weevils at work. A look-out was kept for eggs and these were found as early as June 10th, although no indications of mating were noted before June 21st. The young hazelnuts at this time were about 3/16″ in diameter and the outer shell very soft. Egg punctures were readily detected by the brownish spot on the side of the husk. Some of the nuts had a number of feeding punctures (irregular roughened surface areas) while others only one or two; but excepting an occasional specimen, all nuts showed signs of attack by this date. Punctures were more numerous toward the tip of the nut.

The eggs were deposited near the outer surface of the nut, within the area which later was to be the hard shell, one egg only in each puncture. About July 10th the adults had disappeared and the last of the eggs were hatching. On August 13th several larvae examined at that time appeared to be about full-grown. Each had made a simple tunnel into the kernel, gradually enlarging the gallery as it went, and this to such an extent that in some cases little

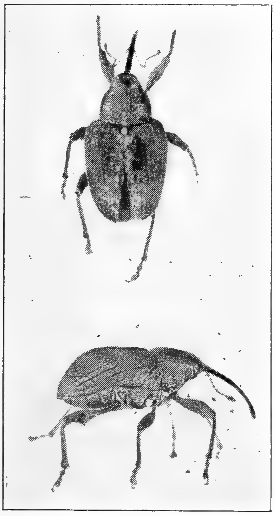
*Peanuts and cocoanuts not included in this list.

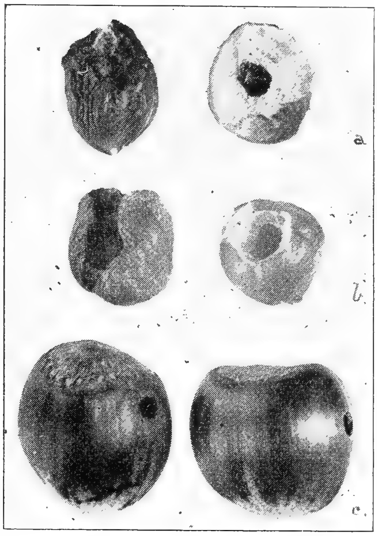
of the kernel was left. These "wormy" nuts later would drop to the ground and the larva in each case leaving its strong good storehouse through a small round hole about midway in the side of the nut and burrowing into the earth.

The winter is passed in the larval stage within a loosely constructed earthen cell just below the surface of the ground, and the weevils emerge the following June.

The adult is about ¼" long, robust in form and of a light grey colour. The snout or beak of the female extends approximately half the length of the body (the male's being shorter), and at the end of this odd-looking projection is a pair of short, pointed jaws which the weevil uses to dig down into the young nuts for food.

The egg is somewhat elliptical in outline, with a smooth and shining surface, whitish in colour and partly transparent. It measures 1 mm. in length.





1 2

1. Hazel nut weevil, *Balaninus obtusus*. Blanch. (×2½ approx.)
2. (*a* and *b*) Nut kernels severely injured by larvæ.
   (*c*) Hazel nuts showing larval exit holes. (×1½ approx.)

The full-grown larva or grub is of a dull white colour about 7 mm. long, the body plump, concavely rounded on the ventral side and without legs; the head being provided with a pair of short, strong jaws.

CONTROL: As the adults feign death readily, this habit can be utilized to trap them. By simply jarring the bushes the weevils fall on a paper or sheet spread on the ground beneath, or will drop into an open umbrella held so as to catch them. After the larva enters the nut it is impossible to get at it; so that defective nuts should be removed from the bushes and any nuts which have fallen to the ground gathered up and burned. Cultivating the soil in spring will expose many of the larvae since they pupate near the surface.

In stored products where the larvae are known to be working, treatment by fumigation with carbon bisulphide will be found a good control. The nuts should be placed in an air-tight receptacle with a small quantity of the liquid poured into a dish, one ounce to the bushel, and then left undisturbed for forty-

eight hours. Caution should be taken in handling carbon bisulphide to keep fire away from it as the gas is inflammable.

REFERENCES: Brooks' Bulletin No. 128 of West Virginia Agricultural Experiment Station is the only publication on nut weevils available. Two pages are given to a general discussion of *obtusus* and only a few brief notes on its life history.

Chittenden in United States Department of Agriculture Cir. 99 devotes but half a page to *obtusus*, while Felt and Osborn simply refer to Brooks.

BROOKS, F. E., Bull. 128, West Virginia Agr. Exp. Sta., 1910.
CHITTENDEN, F. H., Cir. 99, U.S. Dept. Agric., 1908.
FELT, E., Manual Trees and Shrubs, p. 218, 1924.
OSBORN, Agriculture Ent., p. 198, 1916.
BLANCHARD, Brooklyn Ent. Soc., Vol. vii, p. 107, 1884 (description only).

MOSQUITO CONTROL AT OTTAWA, ONTARIO

C. R. TWINN, ENTOMOLOGICAL BRANCH, OTTAWA

INTRODUCTION

Ottawa, in common with many other Canadian cities, is subject to an annual outbreak of mosquitos varying in severity from year to year. The season during which these pests are troublesome is usually confined to the spring and early summer but it may extend, as it did during 1926, into August.

Although mosquitoes are the cause of serious discomfort, particularly to people living in the outlying sections of the city, and in the surrounding towns and villages, and one hears complaints of their bloodthirsty habits on every hand, until recently little or no organized effort has been directed to reduce their numbers in the past. This lethargy on the part of the public is possibly due to lack of knowledge of the life-history and habits of our Canadian mosquitoes and of their susceptibility to easy destruction while in the larval and pupal stages.

Without such knowledge the public is apt to regard the seasonal prevalence of mosquitoes as inevitable, and, with the exception of certain expensive and rather futile measures directed against the adults, to leave their control to natural agencies. Faunal and biological studies of the mosquitoes in the Ottawa district carried out during the past three years have revealed the feasibility of largely ridding this locality of the mosquito nuisance. If only a small proportion of the money annually spent by the public in purchasing anti-mosquito dopes and sprays, and wire screening for verandahs, doors and windows, chiefly to exclude mosquitces, were devoted to the application of organized scientific control measures, this objective would be attained.

During the past year or two, the Dominion Entomologist, in co-operation with the City Health Department, has directed the attention of the people of Ottawa to the possibility and desirability of controlling the local mosquito pests. Rockcliffe village, a residential section lying to the north of Ottawa and immediately adjacent to it, was the first to seek the advisory and supervisory assistance of the Entomological Branch, and a small sum of money to carry out anti-mosquito work was voted by the council in 1925, and again in 1926. The city of Ottawa applied for such assistance early in 1926, and voted a sufficient sum to conduct preliminary control measures.

The Troublesome Mosquitoes and Their Breeding Areas

Before discussing the actual control work it will be in order to give a brie general account of the troublesome mosquitoes, and their principal breeding places. A short account of the latter, together with a fairly complete list of the mosquito species occurring in the district has already been published,[3] and unnecessary reiteration will be avoided as far as is consistent with the proper presentation of this paper.

The species of importance in the Ottawa district (and probably, with few exceptions, throughout Eastern Canada) on account of their abundance and the blood-sucking habits of the adult females, nearly all belong to the genus *Aedes*. These mosquitoes, of which there are several species, develop in temporary bodies of water in the spring and early summer, after having passed the winter in the egg stage, low temperatures apparently being a necessary preliminary to the successful hatching of the eggs. The newly hatched larvae begin to appear shortly after the spring thaw sets in and while the water is only a few degrees above freezing point. The bodies of water in which they develop are of two principal types, i.e., flood waters formed by river freshets, and snow and rain pools.

The principal flood-water breeding areas, affecting Ottawa, lie to the north and north-northeast of the city, along the Quebec shore of the Ottawa river, in the vicinity of Leamy creek and Gatineau Point; on Kettle island and west of East Templeton, extending over several hundred acres of land, the extent and severity of the flooding varying greatly from year to year. Lesser areas, of comparatively minor importance from the point of view of mosquito production, are formed by the Rideau river in Ottawa South and Ottawa East.

The snow and rain pools are scattered about chiefly in outlying sections of the city, and outside the city limits. The more important occur in rather low scrubby bushland, but some are found in open fields, although usually not far from trees.

Control Work in 1925.—The control work carried out by the Rockcliffe authorities in 1925, was directed solely against mosquitoes which were developing in great numbers in snow and rain pools situated in several acres of scrubby woodland, in the immediate vicinity of the village. It was undertaken at a fortunate time, however, for, thanks to a scant winter snowfall followed by a comparatively dry spring, few mosquitoes developed in the flood-water areas, a short distance to the north on the opposite shore of the Ottawa river, and consequently few migrated into the treated section. The material used for this and subsequent control work in the district, consisted of a mixture of 70 per cent. heavy and 30 per cent. light petroleum fuel oils, specially prepared for the purpose by a commercial oil company.

On May 14th, the oil was sprayed on the infested pools by means of garden watering cans and a five-gallon knapsack sprayer, at which time the majority of the mosquitoes were in the full-grown larval and pupal stages. Only eighty gallons of oil were used, but the work was done under close supervision, and proved very satisfactory, nearly 100 per cent. mortality occurring in treated pools. Owing to this work, and the absence of migratory species, Rockcliffe and adjacent sections enjoyed greater freedom from mosquitoes than for many years.

Control Work in 1926. In 1926, Ottawa and Rockcliffe set aside further appropriations to allow of the treatment of mosquito pools and flood-water areas south of the Ottawa river within a short distance of the city limits. At

the inception of this work, it was found that the oil supplied was not nearly so satisfactory as that obtained formerly. When sprayed on water it spread very slowly and collected on the surface in dark patches and globules, and had a tendency to drift to the edges of the pools and there adhere to vegetation.

It was at first thought that this was due to the rather low temperature of the water, and to a too high percentage of heavy oil, but experiments soon dispelled this theory. The oil company secures the oil from several different sources and it is possible that the base of the oil, whether asphalt or paraffin, has a definite bearing on its suitability for anti-mosquito work.

At the suggestion of the Dominion Entomologist, the co-operation of the Division of Chemistry, Central Experimental Farm, was secured. After a series of experiments, Mr. F. A. Herman, of the Division of Chemistry, found that the addition of .004 per cent. of sodium or potassium hydrate to the oil, reduced its surface tension, causing it to spread rapidly and evenly when sprayed on water. For practical purposes three-quarters of an ounce of a 50 per cent. solution of caustic soda in water was added to each gallon of oil, the addition being made in the field, as the oil was poured into the watering cans. In order to keep the caustic in suspension it was necessary for the oilers to constantly agitate the oil by means of sticks, while pouring it on the infested pools. This method proved quite satisfactory, although knapsack sprayers had to be dispensed with owing to the caustic solution collecting at the bottom and being pumped off first. The oil film remained on treated waters for at least seven days, in spite of heavy rains, and completely destroyed all mosquito stages present.

The control work in Ottawa was carried out under the immediate supervision of Dr. T. A. Lomer, City Health Officer, by four men and a foreman equipped with a large motor truck to convey the oil to and from the widely scattered breeding areas. The work was commenced on May 15th and completed on May 27th. The oiling was completely successful wherever applied, and resulted in a large section of Ottawa enjoying comparative freedom from mosquitoes throughout the summer. It also served to demonstrate the great importance of the flood-water breeding areas in the Gatineau Point—Kettle island section, to the north of the city, and to emphasize the need of including them in any comprehensive control scheme. In these areas the predominant mosquito is *Aedes hirsuteron* Theo., a small flood-water species with very bloodthirsty habits which, in years of high river freshet, develops in great numbers and invades Ottawa and adjacent localities.

Flood-water Mosquitoes

In 1926, the Ottawa river freshet* commenced towards the end of April, the rapidly rising water extensively flooding low-lying land on Kettle island and the Quebec shore. The water continued to rise until the end of May, submerging extensive egg-beds of *Aedes hirsuteron* Theo., which had largely remained dry during the previous summer. Within a week or two, the tree lined pools and shallow miniature lakes, formed by the encroaching river waters, were literally swarming with the larvae of this species and, at the beginning of June, the adults were emerging in immense numbers. On June 6th, I visited Kettle island and, on landing on a cleared section of the island, more or less free from trees, I was greeted by large gyrating swarms of *Aedes hirsuteron*

*Data on river levels was kindly supplied by Mr. C. R. Coutlee, Engineer's Branch, Department of Public Works, Ottawa.

that attacked so viciously, in spite of the bright sunlight and a fresh breeze, that it was impossible to remain on the island for more than a few minutes, and I was forced to make a hasty retreat. At this date great numbers had already crossed the Ottawa river and were becoming extremely troublesome throughout Rockcliffe, New Edinburgh and Eastview. A few days later they were beginning to appear in northern sections of Ottawa, and by the middle of June many had penetrated into central sections of the city, more than three miles south of their breeding places, and were causing much discomfort. This species continued to be troublesome until well on into midsummer and, in the neighbourhood of its breeding grounds, persisted until late in August.

Important Points in Oiling

Before discussing other methods and factors in mosquito control it would be as well to make a brief statement of the more important points to be considered in the use of oil against mosquitoes.

Petroleum oils have been used extensively in anti-mosquito work during recent years, but as they vary considerably in their suitability for this work, tests should be made to ensure that the available supply is satisfactory, some time before it is required for use. The oil should spread quickly when in contact with water, forming a thin unbroken film over the surface, without collecting in dark patches or adhering too readily to grasses and foliage. Oil that is too heavy has a tendency to clog portable hand spraying apparatus, and oil that does not spread rapidly is apt to be used in much larger quantity than is actually necessary.

All pools and other collections of water believed to contain mosquito larvae and pupae should be examined prior to treatment, as many likely-looking bodies of water are often uninfested. This may be done by means of a small-mesh strainer such as a coffee strainer which after being passed through the water, may be placed in a white saucer containing water, any mosquito stages present immediately becoming visible. Frequently they are so numerous that they may be easily seen without resorting to this expedient.

The oiling should be delayed until the majority of the larvae are nearly full-grown and some are commencing to pupate. By this time the weather is becoming warmer with the result that the oil spreads more readily. Another reason is that the pupae die more readily than the larvae, and, in addition, any larvae that may have hatched recently are also killed. The work should be carried out under the constant direction of a competent supervisor. The average labourer and gang foreman cannot be expected to perform the work in a satisfactory manner if left to his own resources.

The oiling may be done by means of garden watering cans or knapsack sprayers. If the oil is satisfactory the latter are preferable as they are less wasteful and the spray can be controlled more readily. Particular attention should be paid to the edges of infested bodies of water as it is there that the larvae are often most numerous. Pools lying in exposed situations, such as open fields, should not be sprayed in windy weather, as the wind blows the oil film off the surface into the grass-grown margins. The oilers should be equipped with rubber hip boots and overalls, preferably oilskins.

The Use of Derris in Mosquito Control

The recent paper on the insecticidal properties and uses of derris by Messrs. Kelsall, Spittall, Gorham and Walker[1] led the author to consider the possible

use of this material in some form or other as a substitute for oil in the control of mosquitoes. At the suggestion of Mr. F. A. Herman, and with his co-operation, the derris was tried in powder form, a series of experiments being conducted on mosquito larvae and pupae in the laboratory. The derris was dusted on the water surface at the rate of approximately three pounds per acre, the larvae dying within a period varying from three-quarters of an hour to more than seven hours. In all cases, the larvae, before death, became very feeble, lying motionless and parallel with the surface of the water, moving with difficulty only when rudely disturbed. The pupae died more slowly than the larvae, more than twenty-four hours sometimes elapsing before death occurred.

These experiments served to indicate the possible value of derris, but unfortunately none of the material was available in Ottawa, for field tests, until after the majority of mosquitoes had emerged.

While in Montreal, however, in July, Mr. W. St. G. Ryan pointed out to me a small temporary pool, on the outskirts of a wood, which contained large numbers of larvae of *Aedes vexans* Mgn. The pool was rather more than 200 square feet in area and shallow, with a grass-grown bottom. A mixture of derris and French chalk in the proportion of one part of the former to four of the latter was dusted just before sundown on the surface of the water by means of a small hand dust gun, at the rate of 1½ lbs. of derris to the acre. The material settled well, forming a very satisfactory film of dust over the entire surface. When examined 16 hours later, a considerable proportion of the larvae were dead and many of the living revealed the effects of the derris in their sluggish movements. For certain reasons the pool was not examined again until sixty hours after treatment. On this occasion all the larvae were dead, many floating on the surface of the water.

If in further experimental work derris continues to prove efficient in mosquito control, and if an adequate supply at a reasonable price can be assured, it should be an excellent substitute for oil. Used in dust form with a suitable "filler" it should be possible to treat large breeding areas either with hand-dusters or by aeroplane, the latter working at a remarkably high speed and low cost. In the United States, aeroplane dusting[2] with Paris green, in the control of anopheline mosquitoes, cost only from fifty to sixty cents per acre, and more than two thousand acres were treated per day. Paris green, however, according to investigators in the United States is only effective against the larvae of *Anopheles* which are surface feeders, and does not effect culicine larvae.

Permanent Control Measures

In addition to temporary control measures such as have been already described, much work of a more permanent nature could be carried out in the Ottawa district. Many of the breeding areas, particularly the snow and rain pools, could be permanently removed by properly executed drainage schemes. In many places all that is needed is a few well cut ditches kept in good repair. Other areas could be filled in with such material as city garbage, a measure which has been already started in at least two locations. Finally, the flood-water breeding areas adjacent to the Ottawa and Rideau rivers probably could be greatly lessened by the construction of dykes at strategic points.

Natural Control

Natural agencies, particularly the weather, play an important part in regulating the abundance of mosquitoes. It has been already stated that the

height and duration of the Ottawa river freshet is a deciding factor in the production of flood-water mosquitoes at Ottawa. The freshet, in turn, is regulated by the amount of winter snow fall, spring rains and by temperature. Dry weather in spring frequently results in the extensive drying up of breeding pools, causing the death of great numbers of larvae and pupae. After a short dry spell it is a common sight to see shrunken pools in which the water is literally choked with "wrigglers."

Whenever fish gain access to infested bodies of water, the mosquitoes quickly disappear. In 1926, the Rideau river rose exceptionally high, and in one location certain troublesome mosquito breeding pools remained connected with the river for some time, with the result that they became impregnated with many small fish. No mosquitoes developed in these pools, thanks to the fish, but as the river subsided, the pools dried up and the fish died also.

The larvae of a species of non-biting mosquito, *Corethra cinctipes* Coq., which often occurs in large numbers in temporary bodies of water containing *Aedes* larvae, attack the latter, particularly the smaller, recently hatched ones. Water-beetle larvae are also well-known enemies of mosquitoes and undoubtedly greatly reduce their numbers.

References

1. Kelsall, A., J. P. Spittall, R. P. Gorham, and G. P. Walker, "Derris as an Insecticide," 56th Ann. Rep. Ent. Soc. of Ont., 1925, pp. 25-40.

2. Morse, Stanley F., "Airships for Mosquito Control," Proc. 13th Ann. Meet. N. J. Mos Ext. Assoc., 1926, p. 82.

3. Twinn, C. R., "Notes on the Mosquitoes of the Ottawa District," Can. Ent., Vol. lviii, 1926, pp. 108-111.

PARADICHLOROBENZENE AS A CONTROL FOR THE MUSHROOM MITE

L. Caesar, Ontario Agricultural College, Guelph

While on my holidays in early July, I received a letter from Mr. Carl Peterson of Port Dover stating that his mushroom bed was being severely injured by a tiny mite. A sample of the soil accompanied the letter. On examination I could easily see a tiny white mite, and though I had nothing with me to make sure of its identity, yet from the general appearance and the description of the injury I feel that there is no doubt it was the mushroom mite, *Tyroglyphus lintneri* Osb.

Mr. Peterson, who is a bright young Danish floriculturist, had already tried but without success to control the mite by using calcium cyanide, nicotine liquid, nicotine powder, X L all nicotine, tobacco stems, carbon bisulphide and ammonia respectively. His failure was to be expected because the mite is notoriously hard to combat. Popenoe, in United States Farmers' Bulletin 789, says, "Little can be recommended for the control of the mushroom mite after it has once become established in a house."

Some months previous to receiving this letter I had been sent samples of wheat severely infested with a closely allied mite, *Tyroglyphus farinae* DeGeer, and by experiment had found that a small amount of paradichlorobenzene quickly killed it. Accordingly I sent Mr. Peterson two pounds of this substance and asked him to try it, but warned him to test it first very carefully on a small area for fear it would injure the mushrooms or the mycelium in the soil. Three

weeks later he wrote stating that the poison had been a complete success and had done no injury. The following is his account of the experiment:

"*Treatment 1.*—Strips of paper about 8 inches wide by 1 yard long were placed on the beds in long continuous rows with about 1 yard distance between rows, with paradichlorobenzene crystals scattered on paper in quantities of about 1 lb. to 400 sq. ft. of beds, after which the beds were covered with newspaper. The beds at time of this treatment had even moisture. Sixty per cent. kill of mites.

"*Treatment 2.*—The beds were thoroughly dried out and the crystals scattered evenly on entire surface of bed. (No care used to avoid scattering on mushrooms.) We used for this treatment in quantities of 1½ lbs. to 400 sq. ft. of bed, after which the surface was damped slightly with a fine syringe. No covering used on beds, but entire mushroom house closed tightly for 48 hours, and then given a good airing for a few hours. This treatment was practically a 100 per cent. kill and as far as we can ascertain with not the slightest harm done to mushrooms. We have used this treatment twice in ten days, the second time to get any mites that may possibly have escaped or hatched since first and second treatment.

"You will understand this is encouraging, more so because our mushroom house is an old barn converted, where planks and old boards are used aplenty. The bed referred to covers the entire bottom of house, about 400 sq. ft., which of course would make it more difficult to clean up."

Four weeks later I called on Mr. Peterson at Port Dover and asked him whether any injurious results had shown up in the meantime from the use of the paradichlorobenzene. He assured me he could see no injury and that no mites had since appeared. As a proof of his confidence in the value of the paradichlorobenzene he had purchased five pounds to keep on hand in case of future need.

On November 1st I again wrote Mr. Peterson and asked him whether any injurious effects from the paradichlorobenzene had since been noticed. He replied November 4th as follows:—

"I can confidently say that to the best of my knowledge the paradichlorobenzene has not caused any injury whatever to the beds, spawn or mushrooms, if used in the quantities mentioned in my previous letter."

I have not had an opportunity to test this control myself, but it looks as though we have in it a promising means of control for the mushroom mite. Further work is of course necessary to test whether it is safe under all conditions; what is the best amount to use and how it may best be applied. I hope that Mr. Peterson's success will not cause other mushroom growers to use it recklessly as they would a well-tested remedy, but that they will try it out first on a small area before treating the whole bed. It seems to me that perhaps a wise method to follow would be to cover a portion of the bed with cheesecloth or burlap or some other material of loose texture, then spread the substance over it at the rate of about 1½ pounds to 400 square feet and leave this on for two days and at the end of that time remove the covering, taking with it any of the crystals which had not evaporated. Then if the mites have been killed and if after a couple of days no damage is seen, the whole bed could be treated in the same manner. Of course, if the crystals can be scattered over the bed itself without any cheesecloth or other intervening substance and this does not injure the plants, it would be a great saving of labour. It must be kept in mind that paradichlorobenzene is quite injurious to many kinds of plants, especially when the crystals come in direct contact with them.

NOTES UPON THE INSECT PREPARATIONS USED IN CLASS WORK AT THE OKA INSTITUTE OF AGRICULTURE

REV. FATHER LEOPOLD, LA TRAPPE, QUE.

(Father Leopold, recognizing that there would be a group of student members and visitors present at the annual meetings, felt that some idea of the prepared entomological material being used in class work at Oka would be of particular interest to them. Instead, therefore, of the presidential address as announced on the programme, an excellent collection of microscope slides representative of the mounted material referred to was shown to the meeting. The series embraced prepared material illustrating external and internal anatomy, isolated structures and insects mounted entire. Some of the mountings of large insects were particularly striking. All the material indicated clearly the great value of such preparation and its undoubted advantage in use in class work. The demonstration was followed by a descriptive discussion of methods of preparation by Father Leopold, as follows:—)

The insects, after killing, are put into a ten per cent. solution of potassium or sodium hydroxide, kept at room temperature or in an incubator at from 37 degrees to 50 degrees Centigrade. Though this is the oldest and best known method of removing the soft internal part of the insect and of softening the chitin, it has the disadvantage of also frequently removing such essential structures as hairs and scale. Owing to this difficulty I prefer to use the low temperature and to avoid the use of the Bunsen burner. If, however, rapid work is essential, then warm the solution in the hot water bath for but ten or fifteen minutes.

If the chitin becomes excessively clear by the hydroxide it can be coloured by a solution of pyrogallic acid, alcohol and glycerine, and if overcoloured can be bleached by washing in a weak solution of hydrochloric acid.

After these structures have been suitably softened and cleared of soft material the specimen is washed in acidulated distilled water and later in pure distilled water to remove the hydroxide. The water is removed by immersion in increasingly strong alcohol solutions and finally for short periods in absolute alcohol, clove oil, xylol in succession and mounted in Canada balsam.

In the preparation of dried material the insect can be softened by immersion in a dilute solution of the hydroxide or by soaking in 50 per cent. acetic acid, though I prefer the method of R. du Moyer. In this method the insect is soaked in a 10 per cent. solution of ammonia until it retakes the original shape. The material is then washed and carried forward to mounting in the usual way.

An even more convenient method (chloral-phenol method), one invented by J. Armann for botanical preparations, may be applied to arthropods in general. Either one of two formulae may be used—(1) chloral hydrate (crystals), two parts, with phenol (crystals), one part; or (2) equal parts of chloral hydrate and monochlorophenol (para). In either case the mixture is liquefied over a slow heat and kept for use in a stoppered rubber pipette bottle.

Both liquids are miscible alike in water or Canada balsam without opacity or precipitate, and thus allow mounting direct from the macerating fluid. Care should be taken, however, not to expose small structures to the mixture for too long a time as they become very soft and the parts may become dissociated.

Colourless or transparent chitin can be stained to aid in study by being held in a 1 per cent. solution of pyrogallic acid in distilled water for about thirty minutes. Upon removal the material should be exposed to sunlight in 70 per

cent. alcohol or glycerine for a few hours, depending upon the intensity and colour required. If the colour is too intense, bleaching can be effected by immersion in weak hydrochloric acid till sufficiently decolourized when, after washing, dehydration and clearing, the material can be mounted.

THE ACTIVITIES OF THE DIVISION OF FOREIGN PESTS SUPPRESSION

L. S. McLaine, Entomological Branch, Ottawa

The activities of the Division of Foreign Pests Suppression are divided into two main classes or groups: first, the inspection of imported and exported plants and plant products, including the work involved under the Destructive Insect and Pest Advisory Act Board; and second, the handling of field projects in connection with the suppression or control of foreign pests recently introduced and which have not yet secured a foothold in the Dominion.

Inspection of Plants and Plant Products

All importers of plants from any country are required to secure a permit to cover their importation and which must be presented to the Customs before the shipment can be released. For the year ending March 31st, 1926, a total of 13,730 permits were issued to 6,354 different consignees. Shipments of plants arriving from countries other than the United States of America are subject to reinspection on arrival in Canada either at the seaboard or at destination. During the period mentioned above 30,463,000 plants were examined; these arrived in 22,466 packages and involved 5,555 separate inspections. In 199 shipments, pests or diseases of one kind or another were intercepted. Provision was made two years ago for the handling and inspection of small shipments of plants which arrived by parcel post. These packages are examined either at Montreal or Vancouver. This branch of the work is increasing very rapidly; last season 1,005 packages containing 94,082 plants were inspected at Montreal.

In addition to the inspection of nursery stock, an effort is made to inspect shipments of plant products of all kinds and descriptions entering Canada from foreign countries. This work can only be carried on at ports where inspectors are stationed, and on account of the limited staff, inspections of these products can only be made at times, when the inspectors are free from examining imported nursery stock. A total of 5,692 inspections were made of plant products in 1,049,833 containers. In 83 inspections pests or diseases were intercepted.

It has been realized for some time that, in addition to the danger of importing noxious pests and diseases on shipments of nursery stock and plant products brought in by the regular channels, the question of immigrants and passengers bringing in plants would have to receive consideration. Passenger boats have been attended at the ports of St. John, Quebec, Montreal and Vancouver. At the first three ports inspectors were on hand on the arrival of 318 boats; on 128 boats passengers to the number of 208 were found to be bringing plants with them. If the plants in question were not prohibited entry for one reason or another, they were examined by the inspector and, if free from pests or diseases, were returned to the passenger.

Certain species of plants are prohibited entry into Canada on account of specific pests or diseases; during the past fiscal year 13,490 plants and 19 shipments of potatoes were either seized by the inspectors or refused entry.

During the past few years there has been a very marked increase in the amount of plant materials exported to foreign countries. Last season 326 inspections for export shipments were made, the plants being consigned to nineteen different foreign countries. The products certified included 283,676 plants, 103,766 bulbs, 4,430 pounds of forest tree seed, 25,000 pounds of onion sets, also tobacco plants, tomato plants, etc.

Towards the end of the winter a fumigation and inspection building was constructed at the port of Montreal. This station is 150 feet long by 50 feet in depth. It contains three large fumigation and inspection rooms, a small cyanide chamber, a research laboratory, a large room for the installation of vacuum fumigation apparatus, and a boiler room. When the fumigating apparatus is installed, it is to be hoped that the station will be one of the best equipped of its kind, and will fill a much needed want.

Field Projects

Brown-Tail Moth.—This insect, which was present in large numbers in the provinces of Nova Scotia and New Brunswick during the period 1910 to 1917, has gradually been brought under control. During the winter of 1913-1914 over 25,000 winter nests were collected in Nova Scotia and over 28,000 in New Brunswick. These numbers have been greatly reduced, in New Brunswick no nests having been found since the winter of 1917-1918. During the past season ninety-five nests were collected in Nova Scotia. There are several points in the latter province where breeding is going on, but these are kept under close observation, the worst orchards are sprayed and it is to be hoped that the insect will eventually be exterminated.

Apple Sucker.—This insect was first found in the vicinity of Wolfville, Nova Scotia, in the summer of 1919. It has now spread over the main apple growing sections of that province and into two adjacent counties in New Brunswick. It is a pest that is more or less readily controlled under orchard conditions, but no effective ovicide has yet been found. Consequently there is an embargo on the movement of the host plants of this insect from the infested to non-infested territory. Scouting work carried on this past season indicated that there had been but little spread during the year.

Gypsy Moth.—This pest was discovered in the vicinity of Henrysburg, Quebec, in the late summer of 1924. The infestation covered about one-third of a square mile and 2,845 egg clusters were treated. Extensive control measures have been carried on each year, consisting of the spraying of all foliage, creosoting of egg clusters, burning stone walls and brush likely to harbour young caterpillars, and the placing of burlap and tanglefoot bands on the trees in the infested area, with the result that only one old egg cluster was found this fall. In addition, scouting is being carried on in southern Quebec from the Ontario to the New Hampshire line. This work is being carried on co-operatively with the Quebec Department of Lands and Forests.

European Corn Borer.—During the past summer this insect was found to have spread into sixty additional townships in Ontario and had also invaded the province of Quebec at two different points. With the exception of the outbreak at North Bay, Ontario, the increase in distribution has been due undoubtedly to natural spread. A marked increase in the intensity of infestation was also noted, especially as regards southwestern Ontario.

Mexican Bean Beetle.—This insect, a native of the southwest United States, was found in Alabama in 1920. In one year it spread 4,500 square miles and by 1924 was found on the southern shore of Lake Erie. Scouting to determine whether the pest had invaded Ontario was carried on in 1925 and 1926. Up to the present time no sign of the insect has been found. It is a serious pest of many varieties of bean.

European Pine Shoot Moth.—In the late spring of 1925, a small shipment of pines imported from Europe were found infested with this insect; the shipment was destroyed. Later in the season a report from the Toronto district indicated the presence of the pest, scouting was immediately started and the pine shoot moth was found at several points in this area. In the fall, plans were formulated to re-examine all pines imported since the inauguration of the permit system. This work was started in the spring of 1926, with the result that infestations were found at forty-five points in Ontario, and one in British Columbia. An endeavour has been made to clean up each infestation, and the work will be continued in 1927. The pest is established in at least fifteen states of the United States.

European Corn Borer Parasites.—In 1923 a parasite laboratory was established at St. Thomas, Ontario, for the purpose of rearing and colonizing parasites of the European corn borer. The original breeding material was furnished by the United States Bureau of Entomology. Owing to the severity of the corn borer outbreak in the southwest portion of the province, the laboratory was moved to Chatham in 1925. During the four years the laboratory has been in operation 2,577,000 *Habrobracon brevicornis* and 118,600 *Exeristes roborator* parasites have been liberated. This past summer two new species, an *Apanteles* sp. and a *Microgaster* sp. have been secured and this new material is now being bred.

SOME PRELIMINARY OBSERVATIONS ON THE LIFE HISTORY OF THE ARMYWORM, *CIRPHIS UNIPUNCTA*, HAW.*

H. F. HUDSON AND A. A. WOOD, DOM. ENTOMOLOGICAL LABORATORY, STRATHROY

This paper covers some phases of the life history of the armyworm, *Cirphis unipuncta*, which have been under study at the Dominion Entomological Laboratory, Strathroy, Ontario, during the years 1925 and 1926.

From an economic standpoint, little or nothing has been seen or heard of this insect in Ontario since the memorable outbreak of 1914. At that time the losses to grain crops and pasture fields were estimated to be a quarter of a million dollars in Western Ontario alone, to say nothing of the damage caused in Eastern Ontario, and other parts of the Dominion. It would appear from authentic Canadian records that outbreaks of this insect occur at irregular periods of from fourteen to twenty years, depending possibly upon weather conditions and the presence or absence of parasites and predators.

In normal years the armyworm is difficult to find, and the present investigation has shown that a knowledge of the insect, especially in the earlier instars, is necessary before field observations can be made with profit.

The results of the study in 1925 were negligible. Sugar baiting at night for the moths was started early in the spring, and a worn moth was secured on May 18th. This is very early, and is felt to be an unusual record. No other moths were taken until June 3rd, though the small flight lasted until June 29th. A total of twenty-five moths was secured during the first flight.

Moths were seen again on the wing on July 23rd, and were taken in small numbers until August 13th. During the latter period fourteen moths were secured. Search made in likely situations failed to reveal any larvae and the opinion was felt to be justified that armyworms were very scarce.

In 1926 the same ground was covered, and the spring flight of moths was fairly strong. In 1926 the area of sugaring was slightly enlarged so as to be sure of an ample supply of moths. Moths appeared on the wing on June 17th, and the flight lasted until July 19th, the peak of flight being on June 22nd and 23rd. The spring flight lasted forty-two days, and a total of 192 moths were collected. For rearing, these moths were introduced in to a field cage and the cage results checked by insectary studies.

Oviposition.—On June 3rd, fourty-four moths were collected from sugared baits placed upon fence posts along the road. The sexes were not determined at the time, but were placed four to a bag in 16-pound paper bags containing a small bunch of couch grass (*Agropyron repens*) with a piece of absorbent cotton saturated with dilute blackstrap molasses. An examination of the bags after death of the moths showed that three of the bag cages contained male moths only. Of the other cages each contained three males and one female, and seven females of eight under observation laid fertile eggs. These eggs varied in number per female from 8 to 661; a total of 1,127 eggs were secured with a fertility of 97.97 per cent. and a viability in fertile eggs of 82.57 per cent. No doubt all the fertile eggs would have hatched had humidity conditions been properly regulated, as all eggs showed development. From a study of 801 eggs, the duration of the egg stage was found to vary from four to five days. In bag cages the females have pre-oviposition period of at least ten days, and the possibility is that it may be longer. In the same cages, with only couch grass present, the eggs are usually thrust in between the folded sides of a blade and glued along the grooves with a sticky fluid, the sides of the blade being drawn together so as to hide them effectually. In a study of 1,127 eggs in bag cages with couch grass present, 83.85 per cent. were found in the folded leaf blades, 4.04 per cent. on unfolded leaf blades, and 2.10 per cent. between the leaf sheath and the stem.

Development.—Armyworm larvae pass through six instars. The rate of development may be accelerated by the quantity and nature of food supplied. For instance, those which were fed exclusively on corn leaves matured in forty-one days; with larvae fed upon timothy only the stage was prolonged from forty-eight to fifty days; on oats the period of development was from forty-seven to fifty-three days; and on barley part time the period ranged from forty-seven to fifty-one days. The barley in the latter experiments became too ripe by July 22 and corn leaves were substituted.

When mature the larvae pupate just below the surface at an average depth of half an inch. In a large field cage no pupae were taken below this depth; from this cage 435 male and 611 female pupae were recovered. This number would have been much larger had the wire mesh been fine enough to confine all of the larvae, as during the early instars a number migrated from the cage.

The day after emergence, single pairs of moths, from insectary reared material, were placed in the paper bag cages with grass and molasses, to ascertain the length of adult life, also incidentally to determine whether oviposition would take place under such conditions. A total of twenty-two bags were used. The maximum adult life of male moths was found to be thirty-seven days and the minimum twenty-two days; the maximum adult life of female moths was fifty days and the minimum thirty-two days.

From this material mated only four out of twenty moths oviposited. They laid 120, 75, 429 and 150 eggs, respectively. All eggs proved infertile. Flight seems to be a necessary requisite to successful mating and oviposition. This appears to be proven by the fact that moths taken during flight oviposited freely in paper bags. All the eggs proved fertile, while those placed in bags the day after emergence oviposited sparingly and all eggs thus secured were infertile.

Fall Flight of Moths.—From insectary reared material, moths appeared in the breeding cages on August 15th, exactly one week earlier than those appearing in the field. The fall flight lasted forty-four days, but was not as heavy as that of the spring. In the field, moths first appeared upon sugar-baited posts on August 22nd, and were on the wing until October 4th, the peak of flight being September 5th. A total of 184 moths were secured. Field and insectary cage studies were made with the fall brood and it would appear that the larval stadia, as far as reared in the fall, are slightly longer than those in the spring. The studies are still in progress, and such results are not incorporated in this paper.

THE SPREAD AND DEGREE OF INFESTATION OF THE EUROPEAN CORN BORER IN CANADA, 1926

W. N. Keenan, Division of Foreign Pests Suppression, Ottawa

During the past several meetings of this Society a record of the comparative importance of the European corn borer from year to year has been presented, and each season our report has indicated further spread and more intense infestation. It is regretted that the 1926 statement is no exception and that the corn borer has not only spread over a much larger area than normally, but has increased alarmingly in the important corn growing counties where it has been established for a few years.

Although it is believed that this pest became established in Elgin county in 1910, it was not discovered until 1920, when nearly three thousand square miles were found infested. Since then it has spread rapidly and at the end of the 1925 season had covered all territory south and west of Simcoe and York counties inclusive, as well as all shore townships along the north shore of Lake Ontario and the St. Lawrence River as far east as Brockville, in Leeds county.

This year the scouting has revealed an unexpected spread to new territory with the result that practically all corn growing areas in the province of Ontario are now infested. One or more collections were taken in sixty *new* townships in this province as follows: 2 in Durham county, 2 in Victoria, 3 in Peterborough, 5 in Northumberland, 4 in Hastings, 3 in Lennox and Addington, 10 in Frontenac, 6 in Leeds, 3 in Grenville, 3 in Dundas, 1 in Stormont, 1 in Glengarry, 2 in Prescott, 2 in Russell, 5 in Carleton, 4 in Lanark, 3 in Renfrew, and one collection in the township of Widdifield, Nipissing County, in the vicinity of North Bay.

The above does not represent the full results of the 1926 scouting season. The province of Quebec is now interested in the corn borer situation, as several collections were taken within that province, including three townships in Hull county (north of Ottawa), seven points in the counties of Chateauguay and Huntingdon, and at one point in Lacolle township, St. John's county. The Hull county infestation is undoubtedly due to the general spread which occurred

throughout eastern Ontario, but as the corn borer was found in the vicinity of both Albany and Buffalo in 1919, and the 1926 scouting shows that north-eastern New York state is now infested, it is probable that the infestations in southern Quebec are also due to natural spread.

Degree of Infestation in Infested Territory

During the past three years records of the degree of infestation have been taken at many points within the more important corn-growing districts. This work was continued in 1926, but several points were omitted from the concentric circles radiating from the original centre of the outbreak as well as a few points in other districts, due to the pressure of work and the advisability of extending the observation territory to include the northern shore of Lake Ontario. The following table is a summary of the records procured since the work was started in 1923:

Area	Highest per cent. infestation				Lowest per cent. infestation				Average per cent. infestation				Total number of fields examined			
	1923	1924	1925	1926	1923	1924	1925	1926	1923	1924	1925	1926	1923	1924	1925	1926
Circle No. 1 (6-8 miles)	68.0	99.0	83.0	82.3	4.33	4.6	6.0	7.6	30.16	59.72	40.88	30.7	55	55	40	30
Circle No. 2 (15 miles)	47.0	72.0	77.0	92.0	0.0	3.6	0.3	1.0	16.97	32.52	32.15	39.3	80	80	65	50
Circle No. 3 (30 miles)	7.66	28.3	65.33	91.3	0.0	0.0	0.0	1.6	1.93	7.72	11.09	29.5	135	135	135	75
Brant County	.....	.....	.....	21.3	.....	.....	.....	2.3	.....	.....	.....	10.3	.....	.....	.....	5
Essex County (80-100 miles)	13.66	82.33	100.00	100.00	0.0	0.7	0.0	14.0	1.31	13.53	37.52	83.0	48	85	85	74
Frontenac County	.....	.....	.....	1.0	.....	.....	.....	0.0	.....	.....	.....	0.26	.....	.....	.....	5
Haldimand County	.....	2.6	8.0	8.33	.....	0.01	0.0	1.0	.....	1.14	2.96	3.8	.....	10	10	10
Hastings County	.....	.....	.....	2.0	.....	.....	.....	0.0	.....	.....	.....	0.73	.....	.....	.....	5
Huron County (50-70 miles)	1.4	3.0	9.0	21.0	0.0	0.0	0.66	4.6	0.3	1.36	4.89	11.4	12	10	10	5
Kent County	.....	84.3	100.00	100.00	.....	0.3	4.0	7.0	.....	24.19	52.84	78.7	.....	40	40	25
Lennox and Addington	.....	.....	.....	.20	.....	.....	.....	0.0	.....	.....	.....	0.46	.....	.....	.....	5
Lambton	.....	11.3	14.33	79.3	.....	0.1	0.0	5.0	.....	3.21	5.20	34.0	.....	25	25	25
Leeds	.....	.....	.....	1.0	.....	.....	.....	0.0	.....	.....	.....	0.2	.....	.....	.....	5
Lincoln	0.6	1.6	7.33	23.0	0.0	0.0	0.0	0.3	0.2	0.4	1.16	5.3	15	15	15	15
Norfolk East (45 miles)	1.2	4.6	28.0	17.0	0.0	0.9	1.66	0.3	0.32	2.66	9.79	8.53	5	5	5	5
Northumberland	.....	.....	.....	1.66	.....	.....	.....	0.0	.....	.....	.....	0.6	.....	.....	.....	10
Middlesex (Northwest)	.....	13.3	7.66	54.3	.....	0.6	1.66	2.6	.....	6.46	3.59	28.5	.....	10	10	10
Oxford (40-45 miles)	2.8	12.6	13.0	26.6	0.0	0.0	0.0	4.0	0 93	3.61	3.68	13.7	15	15	15	15
Prince Edward	.....	.....	.....	10.3	.....	.....	.....	0.0	.....	.....	.....	1.9	.....	.....	.....	35
Welland (95-115 miles)	4.4	11.0	36.33	64.3	0.0	0.0	0.0	0.6	1.06	2.92	11.56	23.7	45	45	45	45
Wentworth	.....	.....	.....	3.3	.....	.....	.....	0.3	.....	.....	.....	1.87	.....	.....	.....	5

NOTE.—Mileage stated represents the distance from Union Village, the original centre of the infestation. Welland County first found infested in 1920, and apparently a separate outbreak.

A summary of the above shows that the percentage of stalk infestation within Circle No. 1 has decreased in both 1925 and 1926, a reduction of 25 per cent. occurring this year; Circle No. 2 increased by 21 per cent.; Circle No. 3 increased by 166 per cent.; Essex county, 121 per cent.; Haldimand, 28 per cent.; Huron, 133 per cent.; Kent, 50 per cent.; Lambton, 553 per cent.; Lincoln, 357 per cent.; a reduction of 13 per cent. occurred at our only observation point in eastern Norfolk, which is located near Simcoe, although an increase was noted at several other points in the county by other officers; Middlesex (north west) increased 680 per cent., Oxford 272 per cent., and Welland 105 per cent.

These figures indicate a very serious situation and give one an idea of the crop losses which have resulted. The area along the Kent-Essex county line, in which practical destruction of crop extended over 400 square miles in 1925, has increased this year to an area of approximately 1,200 square miles, no part of either Essex or Kent counties being totally free from ruinous infestation in early planted field corn. The area of extensive loss extended westward to the Detroit river and northward into the southern part of Lambton county. The severe infestation in the Kent-Essex territory has resulted in a marked decrease in corn acreage, corn having practically disappeared from the territory most severely infested in 1925. The records show further that the borer is increasing seriously in Welland county, and in so far as the area on the north shore of Lake Ontario is concerned, Prince Edward county would appear to be the only one where serious damage is likely to result within the next few years. The infestation in the latter county, which was not found infested until 1924, averaged about 2 per cent. this year, but fields showing as high as 10 per cent. infestation were encountered.

The corn borer is now distributed over approximately 35,000 square miles in the province of Ontario, excluding the area concerned as a result of the North Bay collection. About 200 square miles in Hull county, Quebec, are infested, and approximately 550 square miles in southwestern Quebec. The most eastern collection taken in Ontario is 375 miles from the original outbreak in Elgin county, and as scouting records indicate that the infestation in the northeastern counties is well established, it may be recorded here that the pest will apparently thrive under conditions occurring approximately 200 miles north of St. Thomas. The collection taken in the North Bay district is probably due to artificial spread, but it represents the most northern record to date, being approximately 250 miles north of St. Thomas, and the progress of the borer in that district will be watched with interest, although the corn crop fluctuates each season in regard to both quantity and growth. The newly infested areas, comprising the counties of Carleton, Russell, Lanark and Renfrew, are rather important in corn growing, especially ensilage, and the development of the pest should be watched there. The majority of the infested territory in southwestern Quebec is also important, as thousands of acres are grown, but silos are used extensively and may assist greatly in delaying serious outbreaks.

THE OCCURRENCE OF THE EUROPEAN CORN BORER IN ONTARIO IN PLANTS OTHER THAN CORN AND ITS SIGNIFICANCE

J. Marshall, Ontario Agricultural College, Guelph

In the event of a discontinuance of corn growing in the province of Ontario or in any part of it, will the corn borer be able to exist on other plants and, if so, will it be likely to prove a menace in that way? This question, a pertinent one since the European corn borer first appeared in damaging numbers in Ontario, became of primary importance following the alarming increase of the insect in Kent and Essex counties in 1925.

Previous to this, observations on the occurrence of the borer in other plants than corn had been made from time to time by both federal and provincial investigators. This work, done in Elgin county, it was felt, should be augmented by additional observations in Kent and Essex. Accordingly Professor Caesar detailed the writer to a field investigation in the latter counties. Our observations, made in the months of September, October and November of 1925 and 1926, together with related data obtained by other investigators in Ontario, are briefly presented herein.

A.—Artificial Infestation

1921. Crawford and Spencer caged various weeds and garden crops after infesting them with slips of corn leaves bearing corn borer eggs. To quote their notes: "We had no success in establishing larvae on weeds, but a few established themselves on mangels, potatoes, celery, cauliflower, peas, beans, pepper, *radish*, *salvia*, and *aster*." I have no information as to the numbers established, or their stages of development when examined.

1922. Crawford and Spencer caged corn borer moths with the following plants: *zinnia*, tomato, tobacco, cosmos, *bachelor's button*, *barnyard grass*, *green foxtail*, *yellow foxtail*, *pigweed*, *ragweed*, *and lamb's quarters*. Although no eggs were laid on any of these plants growing beside an infested corn field, the moths in the cages laid freely on all but tobacco, tomato, and cosmos, and a small percentage of the larvae reached maturity on each of the different plants on which the eggs were laid.

1924. Spencer placed four pairs of moths in each of three cages over weeds, hops, and oats, respectively. Larvae were recovered in various stages of development varying from second to sixth instar in the following weeds: *green foxtail*, *Canada thistle* and *common pigweed*. In these, 15.25 larvae were established per female moth caged. In the *hops* the larval development ranged from first to fourth instar, 18.25 larvae being recovered per female moth. The *oats*, a total of 397 stems showed 215 stems infested. Most of the larvae were second or third instar. They were decidedly more numerous than in either of the other cages but their exact number was not determined.

Summing up the work on artificial infestation, larvae established themselves on the following plants: *mangel*, *potato*, *egg plant*, *celery*, *cauliflower*, *radish*, *pea*, *bean*, *pepper*, *salvia*, *aster*, *zinnia*, *bachelor's button*, *hops*, *oats*, *barnyard grass*, *green foxtail*, *yellow foxtail*, *pigweed*, *ragweed*, *lamb's quarters* and *Canada thistle*.

In the case of the weeds, migration from one species to another has not been taken into consideration. The studies of this phase of the investigation work are incomplete, but they do show that the corn borer, if necessary, and

if it should oviposit on them, can adapt itself to quite a large number of plants besides corn. Our natural infestation records which follow show, however, that only on very rare occasions does oviposition occur on any plant but corn, and in areas of very heavy infestation, on oats and barley.

B.—NATURAL INFESTATION

1921. From confidential and published reports of Crawford, Spencer and Painter on the year's work I take the following data: In one field of sweet corn in Elgin county the weeds were so heavily infested as to contain 24,400 larvae per acre. Weeds infested in or adjacent to corn fields were: *orchard grass, wild sunflower, blue weed, goldenrod, mullein, yarrow, tumble weed, red root pigweed, lamb's quarter, yellow foxtail, green foxtail, barnyard grass, old witch grass, lady's thumb, wild buckwheat, Canada thistle, burdock, ground cherry, beggar ticks.* Cultivated plants infested were: *geranium, aster, canna, golden glow, squash vines, garden beats, Hungarian grass, Mann's wonder sorghum,* and *dahlia.* With the exception of dahlias and possibly Mann's wonder sorghum, the infestation of these plants was entirely due to migration of the larvae from corn.

1922. Crawford and Spencer found the following to be additional shelter plants: *wild raspberry, apples* (windfall), *burdock, Canada thistle, white sweet clover* and *sugar beets.*

They found that both oats and sugar beets might serve as host plants. In an oat field previously in corn numerous larvae were taken. Estimates placed their number at 77,645 per acre.

The loss to the grower did not exceed more than one-half bushel of oats per acre. No larvae were past the fifth instar stage when the oats were out, and all that did not reach other plants of suitable nature died within two days.

In a sugar beet field there was a fairly general though slight infestation due to migrating larvae bred in an adjoining cornfield. One beet, however, was found infested with three borers far enough from any other infested plants to indicate its being a host.

Tobacco grown beside corn for two years in succession was found infested.

1923. Curled dock, *hollyhocks, gladiolus* and *rhubarb* were added to the list during this summer.

1925. The investigation in 1925 was carried on within a radius of twenty miles of Tilbury, the scene of ruinous infestation of corn that year. The list of shelter plants was increased by the following: *giant ragweed, curled dock, cocklebur, motherwort, common mustard, garden sunflower, velvet-leaved mallow, smartweed, daisy, fleabane, thorn apple, oak-leaved goosefoot, Soy bean* and *white field bean.*

As many as thirty-three larvae were removed from a single giant ragweed plant growing in a cornfield. All infestation of these plants occurred within migrating distance of a cornfield, and although extensive examinations were made among them in areas removed from such, none were found infested.

Tomatoes were entered where growing beside a cornfield and in a few instances considerable loss of fruits took place.

Special attention was given to sugar beets since it was felt that their high sugar content, making them in this respect akin to corn, might also make them suitable as host plants for the corn borer. Many beet fields were examined and the following table, representing infestation of beets adjoining a ruined cornfield, was typical of the conditions obtaining in the Tilbury district:

Row of Beets	Distance from Corn (feet)	Plants entered per 100
1	4	93
2	6	67
3	8	52
4	10	24
5	12	19
6	14	14
8	18	7
10	22	3
20	40	1 } no borers found.
40	80	1 } no borers found.
80	160	1 } no borers found.
100	200	occasional

It will be noted that up to a distance of twenty feet from the corn, the infestation steadily decreases as the distance from the corn increases. This clearly indicates the migratory tendencies of the insect.

Entry of beets at 200 feet was so regular, though slight, that migration seemed unlikely at this distance. Eggs were found on beets earlier in the season by both Baird and Ficht, of the Dominion Entomological Branch, so since previous artificial infestation experiments indicated that larvae could develop on sugar beets, it is likely that in this very heavily infested area beets served to a very slight extent as host plants when near corn fields. However, no sugar beets were found infested farther than 250 feet from infested corn.

Dahlias were found by Ficht infested at a distance of 150 feet from growing corn before the time of expected migration. It is entirely probable that this infestation was a result of oviposition on the dahlias.

Reports of corn borers infesting weeds and other plants not in the neighbourhood of corn fields have frequently been received from farmers. In practically all cases the larvae present were not corn borers.

1926. Additional shelter plants discovered in the past season's work were: *potato*, *carrot* (as many as seven larvae in a single root reported by Baird and Thompson from Petite Cote), *sumach* and *pokeweed*.

Infestation of weeds bordering on oat fields was common this year, four borers being taken from one ragweed plant in such a situation. In the weeds surrounding a six-acre oat field previously in corn but unploughed, it was estimated that there were at least 2,400 larvae. It is fortunate that relatively few fields were as poorly tilled as this one because evidence shows that oats following corn in poorly cleaned fields are more subject to infestation than if grown in well ploughed land. Likewise, when the fence-rows are kept free from stout weeds undoubtedly practically all the larvae, even at the edges of the fields, never reach maturity.

An average of two corn borer larvae per square yard in oat fields was reported by Ficht this past summer as common infestation in the Tilbury district.

Some interesting data in regard to host plants were obtained this year. Barley fields in the vicinity of Chatham and Tilbury were infested at the rate of approximately one larva per square yard, according to Ficht. The writer was unable to find any borers in the weeds bordering on barley fields, possibly because the barley was cut and removed before the majority of the larvae were able to migrate to any extent. Barley, of course, matures a week to two weeks before oats.

Two gladioli were found infested by Dustan in the horticultural test gardens at St. Thomas. I understand that members of the Dominion Branch have also found infested gladioli in these gardens. This year, at least, no corn was growing in the immediate vicinity.

Slight infestations of dahlias were found in several localities in Kent county. These were isolated and clearly resulted from oviposition on the dahlias.

Zinnias not in the vicinity of any other infested plants were slightly attacked near Wheatley, five mature and one fourth instar larvae being taken from 100 plants. Like the dahlias, these plants were almost certainly acting as hosts.

Summary of Natural Infestation Records

1. *Host Plants.*—Aside from corn the following have acted as host plants only in scattered instances, with the exception of oats and possibly barley:

1. Corn—Zea mays L.
2. Dahlias—Dahlia sp.
3. Gladioli—Gladiolus sp.
4. Zinnias—Zinnia elegans Jacq.
5. Oats—Avena sativa L.
6. Barley—Hordeum vulgare L.
7. Sugar Beets—Beta vulgaris var.

2. *Shelter Plants Only* (Weeds):

1. Orchard grass—Dactylis glomerata L.
2. Wild Sunflower—Helianthus sp.
3. Blueweed—Echium vulgare L.
4. Mullein—Verbascum thapsus L.
5. Goldenrod—Solidago sp.
6. Yarrow—Achillea millefolium L.
7. Wild raspberry—Rubus strigosus Michx.
8. Canada Thistle—Cirsium arvense (L.) Scop.
9. Burdock—Arctium minus Bernh.
10. Giant Ragweed—Ambrosia trifida L.
11. Common Ragweed—Ambrosia artemisiifolia L.
12. Curled Dock—Rumex crispus L.
13. Tumbleweed—Amaranthus graecizans L.
14. Ground Cherry—Physalis heterophila Nees.
15. Cocklebur—Zanthium echinatum Murr.
16. Motherwort—Leonurus cardiaca L.
17. Bindweed—Polygonum convulvulus L.
18. Lamb's Quarters—Chenopodium album L.
19 Common Mustard—Brassica arvense (L) Kuntz.
20. Beggar's Ticks—Bidens frondosa L.
21. Green Foxtail—Setaria viridis (L) Beauv.
22. Yellow Foxtail—Setaria glauca (L) Beauv.
23. Velvet-leaved Mallow—Abutilon theophrasti Medic.
24. Smartweed—Polygonum persicaria L
25. Daisy Fleabane—Erigeron canadensis L.
26. Thorn Apple—Datura stramonium L.
27. Oak-leaved Goosefoot—Chenopodium glaucum L.
28. Sumach—Rhus typhina L.
29. Pokeweed—Phytolacca decandra L.
30. Barnyard Grass—Echinochloa crusgalli (L) Beauv.

Shelter Plants Only (cultivated):

31. Apples (windfall)—Pyrus malus L.
32. White Sweet Clover—Melilotis alba Desr.
33. Yellow Sweet Clover—Melilotis officinale (L.) Lam.
34. Potato—Solanum tuberosum L.
35. Tomato—Lycopersicon esculentum Mill.
36. Carrot—Daucus carota L.
37. Soy Bean—Glycine hispida Maxim.
38. White Field Bean—Phaseolus vulgaris L.
39. Garden Sunflower—Helianthus annuus L.
40. Geranium—Pelargonium hortorum Bailey.
41. Aster—Callistephus hortensis Cass.
42. Golden Glow—Rudbeckia lacinata L.
43. Squash Vines—Cucurbita maxima Duchesne.
44. Broom Corn—Holcus sorghum Var. techinus L.
45. Sudan Grass—Holcus sudanensis Bailey.
46. Early Amber Sugar Cane—Holcus sorghum Var. saccharastus L.
47. Hungarian Grass—Setaria italica (L) Beaux.

Plants Common in Infested Cornfields but Never Found Attacked:

1. Prickly Lettuce—Lactuca scariola L.
2. Spiny Annual Sow Thistle—Sonchus asper (L.) Hill,
*3. Soft-leaved Annual Sow Thistle—Sonchus oleraceus L.
4. Perennial Sow Thistle—Sonchus arvensis L.
5. Dogbane—Apocynum sp.
6. Milkweed—Asclepias syriaca L.

*One withered plant found infested in late October.

All of these uninfested plants, it will be noted, have milky juices.

Certain inferences may reasonably be drawn from the observations cited.

1. The corn borer in Ontario may, and commonly does, enter any of the fairly stout weeds common in corn fields, with the exception of those with milky juices. Many cultivated plants are also subject to attack when growing beside infested corn. Infestation of the above plants, irrespective of those mentioned below as host plants, occurs in the late summer or autumn after the borers have matured or nearly matured in the corn.

2. Oviposition occurs on both oats and barley, and larvae can survive to at least the fifth instar stage in oats. However, both crops are harvested before the borers reach maturity. In the case of oat infestation the larvae near the borders of the field are likely to enter and develop to maturity in weeds, but if the field has been properly tilled larval survival would be very small, even under conditions of severe infestation.

3. Oviposition in the field rarely occurs on any crops but corn, oats and barley.

4. The corn borer may and occasionally does develop from egg to maturity in dahlias, gladioli, zinnias, and sugar-beets. It commonly develops to at least the fifth instar in oats and possibly in barley. These seven plants constitute to date the known hosts of the European corn borer in Ontario.

In Conclusion

There are no indications that any other Ontario crops will be injured by the corn borer as long as corn is grown on a commercial scale in the Province.

If, as is expected, the early corn acreage in Kent and Essex counties becomes practically nil in 1927, it is difficult to predict what will become of the moths in this area. Many of them, aided by air currents, will almost surely find their way to neighbouring counties where corn is more abundant, but whether or not even late corn will be seriously attacked remains to be seen. Heavy infestation of oats and barley will probably occur in Kent and Essex in 1927.

As to the fate of the corn borer in event of a so-called province-wide abandonment of corn, our findings lead us to believe that the species would still be perpetuated in the aforementioned host plants, or that in the course of time, in view of a consideration of its host plants in its native habitat, that it might gradually adapt itself to still others such as hemp or hops. As long as there is even a little corn grown in the Province, however, we have reason to feel that the borers will concentrate upon it practically to the exclusion of other plants.

THE LARVAL MORTALITY OF THE EUROPEAN CORN BORER IN 1926

JAMES MARSHALL, ONTARIO AGRICULTURAL COLLEGE, GUELPH

In 1924 and 1925, in papers read before the Entomological Society of Ontario, Professor Caesar gave the results of studies of larval mortality. This year the experiments were continued. The methods employed, similar to those of the previous years, were outlined in the Report of the Society for 1924, so need not be given here. The following table gives a summary of the results.

I. TABLE SHOWING THE MORTALITY OF LARVAE FROM EGGS ARTIFICIALLY PLACED ON CORN PLANTS WHICH WERE KEPT FREE FROM ALL OTHER EGGS

Date eggs placed on plants	Number of eggs per series	Date plants dissected and larvae counted	Number of days	Living larvae	Mortality
July 24..........	900	August 6	13	117	87%
July 24..........	900	August 24	31	99	89%
August 5........	900	August 17	12	122	86.4%
August 5........	900	September 5	31	144	84%
	3,600			482	86.6%

This year weather conditions had apparently a fairly uniform effect on larval mortality from July 24th to August 5th (eggs being classed as potential larvae).

The table below is prepared to show the comparative mortalities in the years 1924, 1925 and 1926.

II. TABLE SHOWING LARVAL MORTALITIES FOR 1924, 1925 AND 1926

Year	Number of days from time eggs were placed on the plants until plants dissected	Larval mortality for each series	Average larval mortality for the year
1924.............	12 24	76.28% 79.19%	77.73%
1925.............	15 30	93.65% 93.5%	93.58%
1926.............	12.5 31	86.7% 86.5%	86.8%

This table shows that, as has been previously pointed out, larval mortality takes place almost entirely in the first week after the eggs have hatched, or, in other words, in the first and second larval instars.

The above yearly averages may now be compared to the average yearly field infestation as found by the Dominion Entomological Branch within a radius of fifteen miles of Union, Elgin county, where our experiments were conducted.

III. TABLE SHOWING CORRELATION OF LARVAL MORTALITY AND FIELD INFESTATION

Year	Average artificial mortality	Average larval survival	Average field infestation Union district
1923	not taken	not taken	23%
1924	77.7%	22.3%	45.5%
1925	93.5%	6.5%	36%
1926	86.6%	13.4%	39%

Admitting that there are factors entering into the artificial work which do not obtain in the field, these are a constant and it will be seen that the records mirror fairly closely the natural infestation. A high mortality in the experiments foretells a decrease in the expected field infestation and *vice versa*. For instance, in 1924 the mortality as found in our experiments was 77.7 per cent. This, as we now know, is for the European corn borer a low larval death rate, so it was not surprising that the field infestation practically doubled that year. Next year the mortality was 93.5 per cent., a high death rate, since only 6.5 larvae survived out of every hundred eggs laid as compared with 22.3 in 1924, or, in other words, about one-quarter as many larvae established themselves. Therefore it was not surprising when, instead of doubling, the infestation in 1925 was reduced one-fifth. This year a mortality of 86.6 per cent. indicates a moderate increase in the field since approximately twice as many larvae survived as in 1925 but only half as many as in 1924. This expected increase is borne out by the infestation records which have just been compiled.

The past year's experiments were conducted at Aylmer, Elgin county, and those of the preceding two years at Union, twelve miles southwest of Aylmer. An egg parasite (*Trichogramma minuta*) produced a distinct though undetermined mortality in 1925, but no parasitism was evident at Aylmer this year.

It might be added that we are experimenting on the factors influencing the mortality of corn borer moths and the number of eggs laid, but as yet we have not done enough work to report further on these. A knowledge of adult mortality and the number of eggs laid is of course necessary before the total effect of weather on the borers can be estimated.

For fear of any misunderstanding it should be kept in mind that the above experiments were carried out in a dairying county where the ordinary farm practice of ensiling or feeding whole nearly all the cornstalks and ploughing under nearly all the stubble does a great deal to prevent a more rapid increase in the number of the borers. In the counties of Essex and Kent, where corn is grown chiefly for husking purposes and where the above methods of dealing with the crop have not up to the present been adopted, even the high larval mortality of 93.58 per cent. would not have prevented a rapid increase in the number of the borers.

THE EUROPEAN CORN BORER—THE OUTLOOK IN ONTARIO

L. Caesar, Ontario Agricultural College, Guelph

My reason for giving this paper is that I felt that those of you who had not been able to keep in close touch with the work on the European corn borer might desire to have a brief summary of present conditions in Ontario and to get some idea of what part the borer is likely to play in the future.

The Present Status of the Borer in the Province

Mr. Keenan has shown that the borer has spread to every county which grows corn to any appreciable extent, and that the percentage of infestation has increased greatly in most of the counties which were infested previously to this year. Let us now look a little more fully into the situation in the Province.

In Essex and Kent, where the method of dealing with the corn remnants has been very favourable for the increase of the borer, all the early or moderately early corn this year had borers—often numerous borers—in every stalk, and even the late corn was heavily infested. The result is that most of the farmers realize that they cannot any longer run the risk of growing corn until the borer has been brought under control; hence there will not be more than 10 per cent. of the normal acreage planted to corn next year. So that the corn industry in Essex and Kent is for the time being already almost ruined.

Lambton, Middlesex, Elgin and Oxford are all, with the exception of small areas, heavily infested, the average stalk infestation throughout them being between 30 per cent. and 50 per cent. Fields in all of these counties can be found with 80 per cent. and in three of them with 100 per cent. stalk infestation.

The increase in every other county west of Toronto has been great so that, though three years ago in most of these counties only a field here and there contained borers, to-day almost every field has them, and in many places the infestation has advanced from less than 1 per cent. in 1924 to 20 per cent. or more to-day. Take for instance Norfolk: In 1924 there was not more than 2 per cent. of an average infestation; to-day for forty-six fields examined in various parts of the county the average was 16.1 per cent. and two fields were found, one with 70 per cent. and the other 75 per cent.

East of Toronto borers can be found in almost any field from Toronto to Belleville for several miles back from the lake. In Prince Edward the borer was found in 1924 in a few places, in 1925 it was found in every township; in 1926 the inspector states he has found it in all but one field out of nearly 600 visited. In one field the infestation was as high as 20 per cent.

At the average rate of spread and increase we may expect borers to be found in practically every corn field in Ontario in three years more.

What of the Future?

The most significant thing to my mind about the situation is: first, the enormous increase of the borer in the Province as a whole since 1920—the year of its discovery; and second, the fact that it is now present, even though in small numbers, in almost every field in most of the corn-growing counties.

In 1920 we probably had about 2,000,000 borers, most of them in Elgin and Middlesex. To-day there are, I am sure, at least 1,000,000,000, or 500 times as many as in 1920. It may be interesting to note that if you figure it out you will find that a 500-fold increase in six years is equivalent to an annual increase for that time of three-fold or even a little less.

So much for the rate of increase. Now let us consider what is the significance of the borers' being present, even though in small numbers, in nearly every field west of Toronto and in many fields in the counties east of Toronto up to and including Prince Edward. This means, first, that the moths have a marvellous instinct to spread out widely instead of concentrating in any one area. This fact has in the past lessened the rate of increase of infestation in most of the older areas. Second, it means that the overflow into new territory will soon cease to play any part; for there will be as many moths come in from most of the counties as will go out from them and thus the conditions for even more rapid increase from now on have been brought about. I am speaking now of counties other than Essex and Kent. These two counties next year at least will, I fear, owing to the high infestation and the dropping to a very large extent of corn growing, send out numerous moths to the surrounding counties.

From what has been said, I think all of us must feel that unless effective control measures are adopted by every corn grower, the corn industry will be ruined before many years.

But you will say, "Can that happen in counties where dairying is the main industry and most of the farmers have silos?" I believe the evidence is strong that it will happen in the most up-to-date dairy counties in the Province. Take, for instance, Oxford and Prince Edward; I had hoped for a very low increase in these counties, because of the large percentage of corn that was ensiled and the nearly general practice of ploughing under the stubble. But the facts show that Oxford is rapidly becoming badly infested. Some fields this year near Ingersoll had nearly every stalk attacked. In Prince Edward, too, as already shown, the rate of increase has been startling.

Will the Parasites Check the Increase?—I believe the importation and rearing of parasites is a wise and far-sighted policy, but I am convinced that we have no good reason to hope that parasites will exert any appreciable influence on the situation for ten years and probably not for twenty or more. We must solve our problem before that.

Will a Saturation Point be Reached?—Some have the hope that when the borers have increased all over the Province to such an extent that, say, 50 per cent. on an average of the stalks are infested, a sort of equilibrium will be established. This is a pleasing idea, but it is merely visionary, and what is happening in Essex and Kent shows that a saturation point or a state of equilibrium will only be reached when there are so many borers per plant that the great mass of them will perish of starvation each year.

Would Late Planting Check the Increase?—Late planting in some counties has saved many a corn field from ruin, but late planting is out of the question in fully half of the Province for even ensilage corn, because the season for growth is already almost too short for good yields. Moreover, as the infestation increases there is good reason to believe that even in the warmer parts of the Province late planting after a time will not save the crop, since egg laying will begin on it earlier and even the number of late emerging moths will be great enough to lead to its ruin.

Can We Hope to Save the Corn?—I believe we can, but only by applying the Corn Borer Act and the Regulations thereunder to each county as soon as the amount of infestation justifies it. At present the Act is in operation only in the worst infested counties and in Prince Edward, because I wanted to learn how to run it on a moderate scale before extending it over a larger area. Next year it will be extended to a good many more counties.

We have not yet proven that even compulsory clean-up measures will result in control, but we have several reasons for thinking they will gradually do so:

1. In even the best dairy counties I have seen fields where the stubble was not ploughed under at all but merely disced in spring and sown. This means all the borers in the stubble would survive. Moreover, not more than 40 per cent. of the ploughing that was done buried the stubble properly. Besides this, there are in all these counties a good many farms without silos and on such there are always numerous stalks and pieces of stalks left lying around long enough for the borers to transform into moths and escape. The Act will enable us to remove these sources of infestation and also to insure that sweet corn in private gardens will be looked after.

2. We can bring about lower cutting of corn for silage and other purposes, which will help to make it easier to look after the remnants in the field.

3. Each inspector will be not only an officer to enforce the law but also an educator who will show the farmer how best to accomplish the destruction of all borers on his farm. He will tell him, too, of improved machinery not beyond his reach to purchase.

4. The great farm implement manufacturers, especially in the United States, have been interested in the problem and have been asked to devise new machinery that will aid greatly in destroying the borers in the crop. Attachments have already been invented to put on corn binders to cut corn at the ground. There is a machine now that will cut, husk and shred the corn as it moves along. There are ploughs which will bury standing corn, at least in spring, and that can be used also to cut the plants just below the ground and lay them in rows to facilitate raking and burning. There are stubble beaters with knives revolving at the rate of 1,700 revolutions a minute which pulverize the stubble. I think, however, that there is room still for further inventions; for instance, we need a better rake to gather stubble and debris on the fields in spring. There is no doubt that machinery will play a big part in the future.

5. Some years the weather is unfavourable for the borers and by taking advantage of this fact we can make a great reduction in their numbers. We had a good example of that in Elgin in 1925 when the infestation was greatly lowered in about half the county.

6. In Massachusetts compulsory legislation has resulted in a large diminution in the number of borers.

Some Difficulties that we must Face

In enforcing the Act we shall have difficulties to meet that may some years prevent our making much progress. The chief of these are:

1. Unfavourable weather. This fall is a good example. We had hoped to have a large proportion of the fields cleaned and ploughed before it froze up. In some counties a great deal has been done, but in others the majority of the fields have been so wet that they have not even been cut. This means a great amount of work to do in the spring when the task of getting in the crop early must also be performed. Then some autumns the ground is so hard that it either cannot be ploughed or if ploughed will break up into large chunks and thus not bury the stubble properly.

2. In the heavily infested area many men are going out of corn-growing and every man who does so makes it harder for those who remain in the business, because the moths from his farm will fly to the neighbours'. This is a great

problem in Essex and Kent and affects also the neighbouring counties, but it will solve itself in a couple of years.

3. In the Province as a whole there has been a growing feeling that, quite apart from the corn borer, it is more economical and profitable to grow alfalfa and sweet clover than corn. Here again, every man who puts this idea into practice makes it harder for those who wish to continue to grow corn. But this, too, will settle itself gradually.

4. Then there is the question of the part weeds or other plants may play in the future as breeding plants for the borer. I am hopeful, however, that this is not going to be a serious matter.

5. There are several more difficulties I could name, but I shall mention only one, and that is the securing of the right man as inspector. This is of immense importance. So far we have been, I think, fortunate.

My paper has not been the kind to fill you with optimism and yet I believe there is good reason why we should face the future in this matter hopefully and with the belief that we shall master the borer in this Province and save the corn industry at least for silage or fodder purposes. I doubt, however, whether it will be possible to grow corn for seed again as formerly in Essex and Kent for several years to come, but I hope that ultimately even this result will be achieved.

THE CURRANT FRUIT FLY, *EPOCHRA CANADENSIS* LOEW, IN MANITOBA, DIPTERA, TRYPETIDAE

A. V. Mitchener, University of Manitoba, Winnipeg

The currant fruit fly attacks red and white currants (*Ribes rubrum* L.), flowering currant (*Ribes aurem*, Pursh.), and probably black currant (*Ribes nigrum* L.) in Manitoba. Instances have been reported of injury to black currants, but it was impossible to verify these reports. In other parts of America where this insect is found, black currants, and also gooseberries, are included in the list of host plants.

The currant fruit fly is probably the most destructive insect attacking red and white currants in Manitoba. The damage is caused by the females ovipositing in the partially grown currants. The developing maggots cause many of the currants to ripen prematurely and drop from the bushes. Other infested currants may remain on the bushes until the uninfested fruit is ripe. Usually, however, there is a heavy drop from the bushes before the uninjured portion of the fruit is ripe. In some instances as much as 50 per cent. of the currant crop falls from the bushes due to the injury caused by this insect. If small white maggots are found within the prematurely ripening currants, one may be certain of the identity of the insect as no other insect attacks this fruit in the same manner in Manitoba.

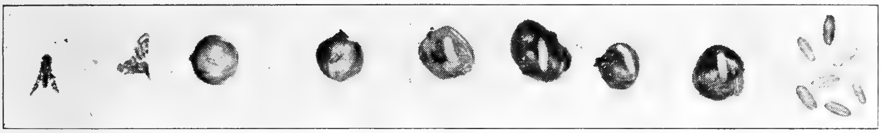
The distribution of this insect in Manitoba is somewhat extended. Records of injury are at hand from practically all of the municipalities adjoining the city of Winnipeg as well as from Winnipeg itself. We also have records from Boissevain, Gilbert Plains, Miami, and Treesbank. It is altogether probable that it occurs throughout the southern part of Manitoba. As currants become more commonly grown in the province we may expect, no doubt, more extensive damage.

Brief Description of Each Stage.—The adult fly is yellowish brown in colour and is somewhat smaller than the housefly. Its most conspicuous markings are on the wings. These are marked with four dark brown cross-bands and one of a similar nature extending along the apical two-fifths of the front margin of the wing. The eyes are shining green. The females are larger than the males, and may also be distinguished from them by the presence of a conspicuous ovipositor.

The egg is a small white object which appears much like a child's elongate toy balloon when examined under magnification. The eggs average one millimeter in length and one quarter of a millimeter in width.

The maggot is white and varies in size according to its stage of development. A pair of black hooks may be seen lying in the anterior part of its body.

The puparium is yellowish in colour. The average puparium varies from four and one-half to five millimeters in length and is two millimeters in diameter.



A *B* *C* *D*

(*a*) Male and female currant fruit flies.
(*b*) Egg showing through skin of currant.
(*c*) Part of currant removed to show maggot.
(*d*) Puparia of currant fruit fly, (slightly reduced).

Life History.—Adult currant fruit flies in a normal year begin to emerge from the soil under the currant bushes about the end of the first week in June. In 1925 the first adults were captured on June 10th and in 1926 on June 9th. At this period of the year common lilacs are just coming into full bloom. Adults were captured from those dates until about July 12th. The adults move about most freely on warm days when they may be taken by sweeping with a net. Frequently adult flies may be seen in the centre of the bush, resting on the leaves where it is shady. The grower would in all probability overlook the presence of these flies in the currant patch, and would learn that they had been there only when the infested fruit began to turn red and drop.

When a female wishes to oviposit she selects a currant about three-quarters grown. Currants of this size are the largest on the bunch at the time the first adults emerge. Evidently currants must be about this size in order that the female may be in an advantageous position to use her ovipositor when she grasps the currant with her feet. On smaller currants the upper side of the currant would be too close to her body for her to do effective work with her ovipositor. After a currant has been selected she bends her ovipositor back underneath the abdomen and slowly inserts it through the skin of the currant. The females observed in the act of ovipositing worked the ovipositor back and forth for from ten to eighteen minutes before appearing satisfied with the opening made in the currant. The mouth parts of the female then began to work back and forth and continued to do this for nearly a minute, after which she left the currant. The egg is left in the currant and is so near the surface that it can be seen through the thin skin if looked for carefully. During 1925 and 1926 the hatching time required for each of twenty-nine eggs was noted. The average time in the egg stage was about six days. Evidently the time, which varied from five to eight days, was determined largely by the temperature of the atmosphere during the egg stage. In late June the eggs required less time to

hatch than they did in mid-June. The young maggot is very small and can be seen with difficulty. Its location is most easily determined by locating the two minute black mouth-hooks which can be distinguished from the surrounding part of the fruit. As soon as the egg hatches the young maggot tunnels underneath the skin of the currant, leaving a white winding air-filled passage. In a very short time, however, it burrows into the centre of the fruit and attacks a seed. Young maggots may nearly always be located feeding on the seeds. The average period spent in the maggot stage is about thirteen days, the extremes being from eleven to sixteen days. When full grown the maggot makes an exit hole through the surface of the currant and emerges. At this time the currant may be either lying on the ground or still hanging to the cluster on the bush. In either case the maggot wriggles out and enters the ground where pupation takes place. If the currants are too badly dried up before the maggot attempts to emerge, it may become stuck in the hole and perish. The maggots enter the soil under the bush where they developed. Puparia were recovered at soil depths varying from a half-inch to three or four inches. The puparia lay in all positions in the soil. The pupal stage lasts for about eleven months. There is only one brood per year. The following tabulation shows some details of the life history of the currant fruit fly.

DATA ON LIFE HISTORY, 1926

Number	Adults introduced	Egg found	Egg hatched	Maggot pupated	Time in egg stage	Time in maggot stage
1	....	....	June 23	July 6	....	13 days
2	....	....	June 23	July 5	....	12 days
3	....	....	June 26	July 8	....	12 days
4	June 21	June 22	June 28	....	6 days	....
5	June 21	June 22	June 28	Maggot died	6 days	....
6	....	June 22	June 29	Maggot died	7 days	....
7	June 22	June 23	June 29	Maggot died	6 days	....
8	....	June 23	June 29	Maggot died	6 days	....
9	June 21	June 22	June 29	July 12	7 days	13 days
10	June 23	June 24	June 29	July 12	5 days	13 days
11	June 23	June 24	June 29	July 12	5 days	13 days
12	June 24	June 25	June 30	July 16	5 days	16 days
13	June 24	June 25	July 1	July 12	6 days	11 days
14	June 29	June 30	July 5	....	5 days	....

An examination of many prematurely ripening currants failed to reveal the presence of a maggot or an exit hole from which the maggot had escaped. All of these berries showed evidences of holes made by the ovipositor of the fruit fly. Different lots of ripe and fallen berries were collected from time to time and placed on sifted soil in large glass jars. All of the currants collected had been visited by the female fruit fly, as they showed the mark of her ovipositor. In all some 1,700 currants were collected. Maggots issued from only 12 per cent. of this number. It would seem, therefore, that either the flies do not actually lay eggs in every currant punctured or many maggots perish within the currants before they reach maturity. In any event currants so punctured ripen prematurely and fall from the bushes with a resultant loss to the grower.

The work outlined above was carried out at Manitoba Agricultural College, Winnipeg, during the years 1925 and 1926. No parasites were reared from any

of the material under observation during that time. The work was carried out in the field, in the laboratory, and in a screened outdoor insectary.

Summary

The currant fruit fly has one brood per year. It is injurious to red and white currants and flowering currant in particular in Manitoba, and probably attacks black currant and possibly gooseberry. The injury is caused by currants being attacked by the females. They ripen prematurely and fall from the bushes. Fully 50 per cent. of the currants may be lost in this way in certain seasons. The egg hatches in about six days, the maggot develops in about thirteen days, and the insect is in the pupal stage about eleven months. The adults occur from about the end of the first week of June until about July 12 in a normal year. No practical method of controlling this insect has as yet been successfully demonstrated.

AN OUTBREAK OF THE TURNIP APHID

Aphis pseudobrassicae Davis

L. Caesar, Ontario Agricultural College, Guelph

About August 1st rumours of turnips being injured by aphids began to be received, and on August 5th a call for help came in from the Vimy Ridge Farm near Guelph. I at once went to the farm and found that the outbreak was serious, almost every plant in the field having numerous aphids on the under side of the leaves.

Extent of the Outbreak.—At Vimy Ridge I learned that the aphids were equally numerous on several neighbouring farms, and that some of the farmers had already begun plowing down their turnips because they felt the crop was ruined. Gradually, as reports arrived from various localities, it was found that the outbreak was very extensive and covered a large part of the province, extending at least as far west as Elgin county and as far east as Prince Edward and north to at least Palmerston. It may have been all over the province, but I did not receive any complaints from the other parts.

Identity of the Species.—A glance at the aphids would reveal to anyone familiar with our common cabbage aphis, *Aphis brassicae*, that the culprit was not this species but a different one, for *A. brassicae* is conspicuously covered with a whitish powder giving it a mealy appearance, whereas the species in question, later identified for me by Mr. W. A. Ross as *Aphis pseudobrassicae*, was free or almost free from any powdery covering and the body colour was yellowish green often with a tint of brown.

On looking over the *Canadian Insect Pest Review* for October, 1926, I found on page 42 that there had been an important outbreak of this species of aphid in Alberta with serious loss to the crops. I also noticed that in the Maritime provinces an aphid had been very destructive and abundant on turnips and cabbage, but in this case the species was not given. It will not be

surprising if it turns out to have been the same species,* and in that case we have had a remarkable outbreak almost all over Canada.

In the course of my own work since 1908, I have seen several severe outbreaks of *A. brassicae* on turnips as well as cabbage, but I have not before seen any outbreak of *A. pseudobrassicae*, though it may possibly have been this species that was involved last autumn in a local infestation of turnips in Waterloo county, which I did not have a chance to examine.

Of *A. pseudobrassicae*, Professor J. J. Davis says that it was unknown to science until 1914, that it has a very wide range in North America, from Manitoba to Texas and from Massachusetts to California, and that it is remarkably prolific, even more so than the pea aphis.

Whether it is a native species has apparently not been discovered. If it is imported it must have come to North America very many years ago to have become so widely distributed.

Food Plants.—The only plants I found it attacking were fall and Swede turnips. I examined cabbage but found none on it. Rape and other cultivated cruciferous plants were not examined, but there were no reports of injuries to any of these though the aphids may have been present on them.

Davis found that turnips and radishes were favourite food plants, but from the reports of various writers it seems clear that it feeds also on cabbage, rape, wild and cultivated mustards, shepherd's purse and several other cruciferous plants.

Control Experiments.—The following sprays and a dust were tested by me at Vimy Ridge:

1. Soap, 1 pound to 4 gallons of water.
2. Derrisol, 1 can to 70 gallons of water, which was a little stronger than recommended by the manufacturers.
3. Nicotine sulphate 40 per cent., ½ pound plus 3 pounds soap to 50 gallons of water.
4. Kerosene emulsion, approximately 8 per cent., the emulsion being made with several times the ordinary amount of soap.
5. Two per cent. nicotine dust, 5 pounds nicotine sulphate 40 per cent., and 95 pounds hydrated lime.

The sprays were applied with a power sprayer at a pressure of 150 to 200 pounds. One line of hose was used and a three foot iron rod equipped with two disc nozzles The rod was bent near the tip so that the spray could be shot up above the under side of the leaves. With this good equipment every care was taken to make a thorough job, but an examination of the plants a day later showed disappointing results; for, though numerous aphids had been killed by all the mixtures, a sufficient number had escaped to have made re-infestation in a week or so certain if natural forces had not stepped in and destroyed nearly all the aphids.

Of the sprays kerosene emulsion was the most effective, probably because it spread much more readily and widely than the others. Soap was not satisfactory with the outfit used, because the great amount of froth made by the agitator prevented the spray from going through the nozzles freely. Had there been no agitator it would probably have been as good as the kerosene emulsion.

The nicotine dust was applied by a cyclone bellows duster, which had a spoon-like tip on the outlet pipe which made it possible to apply the dust to

*Since writing the above, Mr. Ross has informed me that he has identified this species as *Aphis pseudobrassicae* Davis. Hence the outbreak has been almost Dominion wide, and comparable to the great outbreak of the Corn Ear Worm, *Heliothis obsoleta*, in 1921.

the under side of the leaves. In spite of this I found that a perfect job could scarcely be done without treating each row from both sides. By doing so almost 100 per cent. of the aphids could be killed. A couple of days later Mr. J. A. Flock, in my absence, dusted the college turnip field with a power duster and the same mixture. The duster pipe was equipped with a short T at the outlet, and a long canvas was dragged behind over the plants to concentrate the dust on them. Although the dust was not applied so heavily as he would have liked to apply it, yet the results were, in his opinion, fairly satisfactory but not 100 per cent. kill.

Conclusion re Spraying and Dusting

From the above experiments I am convinced that this aphis will not be combated satisfactorily on any large scale by spraying, and that dusting is the only method which will prove effective. Dusting, however, costs about $10 per acre and requires that the farmer have a good hand or power duster, hence I doubt very much whether any one but a market gardener would go to the expense of using the dust.

Duration of the Outbreak.—The outbreak must have been well under way about the beginning of the last week of July. It reached its height by about the 10th of August, and nearly all the aphids had disappeared by the 17th of August. The cause of their disappearance was not investigated closely, but from what I saw in a field east of Toronto I think it was due chiefly to a fungus disease. Hymenopterous parasites helped some at Guelph, but there were very few ladybird beetles or syrphus fly larvae here, though the latter were numerous on turnip leaves sent in from Stratford.

It may be of interest here to note that a severe local outbreak on cabbage of *A. brassicae* in Essex county, which I examined on August 17th, was found to be rapidly being brought under control by a host of ladybird beetles (*Hippodamia convergens*), aphis lions, syrphus fly larvae, hymenopterous parasites and Cecidomyid larvae.

The Amount of Damage.—As to the amount of damage done by the aphids I was not able to spend the necessary time to make an accurate estimate. I observed, however, that wherever the plants were large and vigorous they seemed to survive the attack and to develop into good sized turnips. Wherever they were small and weak, as a great many were, due either to time of planting or other factors, the aphids practically ruined them. In Wellington county the agricultural representative estimated that the crop had been lessened by at least 50 per cent. There is no doubt that in several of the other counties there was also a large loss though probably not so high as in Wellington.

Conclusion.—Farmers and entomologists are wondering whether this aphid is likely to be abundant in the future. One can only conjecture on this point, but it seems to me that since the aphid has been here for many years and has not caused us any appreciable damage until last year, so far as I know, that there must have been remarkably favourable conditions to have led to this year's outbreak, and these conditions are not likely to occur again for a good many years. Another outbreak like we had this year would mean that most farmers would cease growing turnips and would substitute sugar beets or mangels for them.

SOME NOTES ON THE OVIPOSITION HABITS OF THE TARNISHED PLANT BUG, *LYGUS PRATENSIS* LINN, WITH A LIST OF HOST PLANTS

R. H. Painter, Entomological Branch, Ottawa

During the last eighty years a great deal of investigational work has been carried on by Canadian and United States entomologists, with the tarnished plant bug, *Lygus pratensis* L. However, in most of these studies, the oviposition habits and the relation of broods to host plants do not seem to have been very carefully covered, the bulk of the work consisting of experiments leading directly to control.

The following is an extract from a paper presented before the Entomological Society of Nova Scotia in 1917 by Brittain and Saunders, and sums up the oviposition records of this insect to that date:

"According to Crosby and Leonard, Slingerland, in his noteis on this insect, records his observation of a female actually in the act of ov position in the following words: "I saw one egg laid, the time occupied in the oviposition being nearly a minute. The ovipositor was sunk in the tissue of the midrib nearly to its full extent.' He also records that the eggs are occasionally inserted into the blossom of dahlias, sometimes to the number of eight. These workers, in the same bulletin, further record the finding of eggs deposited in the tender tips of peach nursery stock and in the flower heads of the daisy blossom (Erigeron ramosus). Taylor and Collinge describe the oviposition in young apple fruit. Chittenden and Marsh record finding the eggs inserted in the upper side of the leaf of kale. They further state that in the case of the mullein, which is the food plant for the purpose in the District of Columbia, the eggs are inserted in the petiole or leaf stem and in the midrib. The eggs are placed very close together and in confinement; as many as nine were counted on a single leaf an inch long and half as wide. Regarding this point, Haseman writes as follows: In this region* it deposits its eggs in the fall of the year at least, only in the blossoms of flowers such as daisies, asters, mare's tail (Erigeron canadensis), etc.

It is uncertain, from the writings of the foregoing authors, just what brood they had under observation, as the exact number never appears to have been determined with certainty.

Brittain and Saunders also record the finding of eggs of the overwintering adults on sheep sorrel (*Rumex acetosella*) and eggs of the first generation on beets, mangolds and probably white turnips.

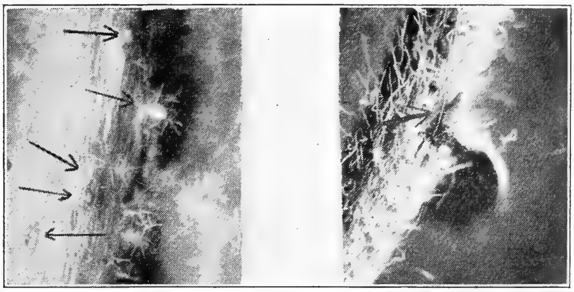
In the spring of 1925 a biological study of this insect was undertaken at Ottawa, Ont., by the author and the egg-laying habits in relation to broods and host plants have been given particular attention.

The field observations to date have shown that the following plants are used as hosts in the Ottawa district by the adults of the overwintering brood:

1. Common mullein—*Verbascum thapsus* L.
2. Black currant—*Ribes nigrum* L.
3. Wild currants—*Ribes* sp.
4. Night flowering catchfly—*Silene noctiflora* L.
5. Strawberry—*Fragaria* sp.
6. Common mustard or charlock—*Brassica arvensis* L.
7. Sheep sorrel—*Rumex acetosella* L.
8. Ox-eye daisy—*Chrysanthemum leucanthemum* L.
9. Common dandelion—*Taraxacum officinale* Weber.

*Missouri.

Of these the dandelion, black and wild currants, night flowering catchfly, and ox-eye daisy are, as far as is known, new records; the others have been recorded by previous workers, although in all cases the brood responsible has not been indicated.



A

(*a*) Showing 5 eggs of the tarnished plant bug, *Lygus pratensis*, *L.* on midrib of mullein leaf.

B

(*b*) Showing egg of tarnished plant bug, *Lygus pratensis*, *L.* oviposited through a bract on a strawberry stem.

The eggs of this insect are laid in such a variety of ways that it is impossible to state any definite location in which they may be found. Thus in the early season eggs were found in the leaf buds of currants and later, as the leaves unfolded, in the petioles. On Mullein, eggs were found in the midribs and the larger leaf veins; on the night flowering catchfly, in the blade of the leaf; on strawberries, in the pedicel of the flowers; on ox-eye daisy, in the receptacle of the flowers; and on willow in the second year bark.

The method of insertion also varies a great deal; in some cases the eggs are buried for their full length in the tissue; in others the egg may protrude for practically its entire length, or only a small tip may remain exposed; and occasionally they may even be found lying loose on a fold in the leaf.

In regard to the regularity of their occurrence in the tissue, or the system of laying followed, there does not seem to be any rule. Eggs are usually found distributed singly though they may be in groups, as many as eight having been counted in a square centimetre on the midrib of a mullein leaf.

Eggs of the overwintering adults were first taken on May 22nd, 1926; these eggs hatched in a few days and the nymphs reached maturity about the middle of July. The adults of these nymphs can, therefore, be called the spring generation.

In field observations eggs of the spring generation were noted in the following plants: 1. Beets. 2. White turnips. 3. Swiss chard. 4. *Helichrysum*. 5. *Erigeron* sp.

Of these, swiss chard and *Helichrysum* are, I think, new records, and Brittain and Saunders' record on white turnips, which was in doubt, is verified.

In conjunction with the field studies caged experiments were also carried on in cheesecloth covered cages, 1′ x 1½′ x 2′ in size, in which from forty to fifty adults were placed. In carrying on this experiment, branches or cuttings of plants, which had been carefully examined for eggs and found free, were placed in vials of water, the neck of the vial being plugged with cotton. These

vials were then sunk in the soil in the cage to bring the neck level with the surface. The adults used were collected in the field and consisted of males and females. Plants were allowed to remain in the cages for periods ranging from twenty-four hours to one week, but in all cases the results were the same. The following comprises a list of plants upon which eggs from overwintering adults were obtained in these cages:

1. Apple—*Prunus* sp.
2. Choke cherry—*Prunus* sp.
3. Black currant—*Ribes nigrum* L.
4. Cultivated aster—*Aster* sp.
5. Chickweed—*Stellaria media* L., Cryid.
6. Horsechestnut—*Aesculus* sp.
7. Willow—*Salix* sp.
8. Prickly lettuce—*Lactuca scariola* L.
9. Milkweed—*Asclepias syriaca* L.
10. Canada fleabane—*Erigeron* sp.
11. Catnip—*Nepeta cataria* L.
12. Common mustard—*Brassica arvensis* L., Klize.
13. Curled dock—*Rumex crispus* L.
14. Golden rod—*Solidago* sp.
15. Flax—*Linum* sp.
16. Rugel's plantain—*Plantago rugelii* Dene.
17. Sheep sorrel—*Rumex acetosella* L.
18. Timothy—*Phleum pratense* L.
19. Buckwheat—*Fagopyron esculenium* (Tourn) L.

In addition to the foregoing, the following plants were similarly exposed in egg-laying experiments without success:

1. Elderberry—*Sambucus canadensis* L.
2. Kentucky blue grass—*Poa pratensis* L.
3. Couch grass—*Agopyron repens* L.
4. Orchard grass—*Dactylis glomerata* L.
5. Red clover—*Trifolium pratense* L.
6. Chickory—*Cichorium intybus* L.
7. Vetch—*Vicia* sp.
8. Peppergrass—*Lepidium virginicum* L.

It is our opinion that these plants were refused, due to the comparative hardness of the tissues. So far as the grasses are concerned, the structure of these plants is apparently not such as to induce the insect to oviposit.

The following list comprises plants upon which eggs were obtained from adults of the spring generation in cages: 1. Cabbage. 2. Potato. 3. Horseradish. 4. Tomato. 5. Aster. 6. *Helenium*. 7. *Nicotiana*. 8. Seed lettuce.

The plants recorded as hosts of the spring generation in the field were also readily oviposited upon when placed in cages.

From these lists can be summed up the following information:

In field observations there has been established nine known field hosts of the overwintering brood of the tarnished plant bug and also sixteen other hosts upon which it has been possible to secure eggs in cages, making a total of twenty-five. Also there are five hosts of the spring generation recorded in the field, and eight additional ones upon which eggs were oviposited in cages, making a total of thirteen. Thus we have altogether thirty-eight species of plants in the Ottawa district upon which eggs of this insect have been found.

It should be noted that in no case were plants, which had been favoured as hosts by the overwintering generation, found to be hosts of the spring generation.

THE ENTOMOLOGICAL RECORD, 1926

NORMAN CRIDDLE, ENTOMOLOGICAL BRANCH, DOMINION DEPARTMENT OF AGRICULTURE

The year 1926, while rather unfavourable for collecting, was noteworthy for marked entomological activity, and collectors have been busy in nearly every province of the Dominion. Much progress has been made in determining specimens and as a result we are able to provide two important lists on distribution.

Among the numerous entomological publications issued during the year the following should be of particular interest to our readers:

Hemiptera of Eastern North America, by W. S. Blatchley, Nature Publishing Co., Indianapolis, Ind. This important work has not yet come to hand, consequently we are unable to review it. Its importance to hemipterists, however, cannot be doubted.

Revision of the North American Moths of the Subfamilies Laspeyresiinae and Olethreutinae, by Carl Heinrich, Bul. 132, U.S. Nat. Mus., 1926. This paper is a continuation of the revisionary work begun in Bulletin 123 and reviewed in a previous issue of the Entomological Record; it contains many references to Canadian species, several of which are described as new. It is indispensable to workers of the micro-lepidoptera.

Die Chrysops-Arten Nordamerikas einschl, Mexicos (The Species of Chrysops from North America, including Mexico), by O. Krober, in Stettiner Entomologische Zeitung, pp. 209 to 353, 2 plates. This paper, which is the most important contribution to the study of the North American species of *Chrysops* yet published, lists and describes seventy-six species, six of which are new, five of these being from Canada. There are sixty illustrations of wings and abdomen. The following new synonymy is recorded, the names in parenthesis falling to the preceding name: *incisus* Macq. (*neglectus* Will); *wiedemanni* Krob., (*obsoletus* Aut.); *obsoletus* Wied. (*morosus* O.S.); *lateralis* Wied. (*hilaris* O.S.); *geminatus* Wied. (*fallax* O.S.); *fuliginosus* Wied. (*plangens* Wd.). Other synonymy is suggested and much of that already recorded verified from examination of types. (H.C.)

North American Species of Two-winged Flies Belonging to the Tribe Miltogramminae, by H. W. Allen, Proc. U.S.N.M., LXVIII, Article 9, pp. 1-106 (5 plates). This is a thorough discussion of a group of Sarcophagidae which has generally been included in the Tachinidae. All information concerning the group has been brought together and excellent illustrations render the keys easy to follow. Much of the material discussed is from Canada. (H.C.)

NOTES OF CAPTURES

Species preceded by an asterisk (*) described since the last Record was prepared.

LEPIDOPTERA

(Arranged according to Barnes and McDunnough's Check List of the Lepidoptera.)

Pieridae

34 *Pieris protodice* Bdv. & Lec. Montreal, Que., Sepr., (A. C. Sheppard).
57a *Eurymus hecla glacialis* McL.
Oeneis melissa assimilis Butl. (*arctica* Gibs).
Oeneis polyxenes subhyalina Curt.
139 *Erebia rossi* Butl.

193a *Brenthis chariclea arctica* Zett.
196 *Brenthis polaris* Bdv.
197b *Brenthis improba* Butl.

The above seven species or subspecies were taken on Baffin Island by J. D. Soper.

* *Euphydryas nubigena beani* ab. *blackmori* Gun. Victoria, B.C., (Blackmore).
* *Euphydryas perdiccas* ab. *nigrisupernipennis* Gun. Chilcotin, B.C.
* *Euphydryas taylori* ab. *victoriae* Gun. Victoria, B.C.
* *Melitaea palla* ab. *blackmori* Gun. Lytton, B.C.
* *Brenthis epithore* ab. *obscuripennis* Gun. Chilcotin, B.C.
* *Brenthis myrina* ab. *serratimarginata* Gun. Vernon, B.C.

The above six aberrations described in Ent. News. Vol. xxxvii, No. 1, 1926.

* *Eurymus interior* form *napi* B. and Benj. Nepigon, Ont.
* *Eurymus pelidne* form *beri* B. and Benj. Alberta.
* *Coenonympha inornata* race *quebecensis* B. and Benj. Chelsea, Que.
* *Dryas (Argynnis) atlantis* race *beani* B. and Benj. Banff, Alta.
* *Brenthis aphirape* race *nichollae* B. and Benj. Rocky mountains, B.C.

The above five forms described in Bul., S., Cal., Ac., Sc., Vol. xxv, Part 3, 1926.

Sphingidae
747 *Deidamia inscriptum* Harr. Point Pelee, Ont., June, (Walley).

Arctiidae
943 *Hyphoraia lapponica* Thun. Baffin Island, (Soper).

Noctuidae
1192 *Schinia arcigera* Gn., Aweme, Man., Aug., (J. F. May).
1219 *Agrotiphila quieta* Hbn. Baffin Island, (Soper).
1229 *Porosagrotis dolli* Grt. Saskatoon, Sask., May, (King).
1240 *Euxoa olivia* form *anacosta* Sm. Vernon, B.C., Sept., (E. P. Venables).
1318 *Euxoa bostonensis* Gt. St. Thomas, Ont., (L. James).
1327 *Euxoa recticincta* Sm. Sasktoon, Sask., Aug., (King).
2201 *Sympistis zetterstedti* Stand. Baffin Island, (Soper).
2206 *Epigaea decliva* Grt. Montreal, Que., (Sheppard).
2281 *Trachea spaldingi* Sm. Saskatoon, Sask., June, (King).
* *Syneda pedionis* Hamp. Winnipeg, Man., (Wallis). Red Deer River, Alta., (Wolly-Dod).
* *Syneda nichollae* Hamp. Ashnold, B.C., (Mrs. Nicholl).

The above two species described in Lepidoptera Phalaenae of the Subfamily Noctuinae, British Museum (Nat. Hist.), 1926.

2304 *Eremobia jocasta* Sm. Toronto, Ont., Sept., (Parish).
3359 *Anticarsia gemmatilis* Hbn. Montreal, Que., (Sheppard).

Cosmopterygidae
Psacaphora deceptella Braun. Quamichan Lake, B.C., (Hanham).

Gelechiidae
6062 *Evippe prunifoliella* Cham. Fraser Mills, B.C., (Marmont).

Oecophoridae
6437 *Agnopteryx canella* Busck. Chilcotin, B.C., (G. V. Copley).
6470 *Agnopteryx nubiferella* Wlshm. Shawinigan Lake, B.C., (Blackmore).

Aegeriidae
6745 *Memythrus fraxini* Hy. Edw. Niagara Falls, Ont., July, (Whalley).

Eucosmidae
6840 *Argyroploce mengelana* Fern. Baffin Island, (Soper).
Thiodia olivaceana Riley. Pt. Pelee, Ont., June, (G. S. Walley).
Thiodia lapidana Wlshm. Chilcotin, B.C., (Copley).
Thiodia alterana Hein. Chilcotin, B.C., (Copley).
Eucosma conspicienda Hein. Chilcotin, B.C., (Copley).
Epiblema brightonana Kft. Aweme, Man., July, (Criddle).
Gypsonoma parryana Curt. Baffin Island, (Soper).
Zeiraphera diniana Gn. Hopedale, Labr., July.
Exentera costomaculana Clem. Putnam, Ont., May, (Walley).
Epinotia normanana Kft. Maniwaki, Que., June, (Curran).
Anchylopera platanana Clem. Pt. Pelee, Ont., June, (Walley).
Anchylopera semiovana Zell. Pt. Pelee, Ont., June, (Walley).

Tortricidae

Sparganothis pulcherrimana Wlshm. Pt. Pelee, Ont., June, (Walley).

Hapoloptiliidae

7737 *Haploptilia accordella* Wlshm. Fraser Mills, B.C., (Marmont).

Gracilariidae

7904 *Lithocolletis incanella* Wlshm. Sooke, B.C., (Blackmore).

Tineidae

8281 *Tinea arcella* Fabr. Fraser Mills, B.C., (Marmont).

Lampronia piperella Busck. Paradise Valley, B.C. (W. B. Anderson). Salmon Arm, B.C., (W. R. Buckell). Kaslo, B.C., (Cockle).

Lampronia sublustris Braun. Kaslo, B.C., (Cockle).

Incurvariidae

8442 *Greya punctifella* Wlshm. Victoria, B.C., (Blackmore and Carter).

Greya subalba Braun. Vernon, B.C., (Ruhmann). Ft. Steel, B.C., (Anderson).

Chalceopla cockerelli Busck. Mt. Tzouhalem, B.C., (Blackmore).

Pterophoridae

The following list of Canadian Plume Moths, prepared by Dr. J. McDunnough, is as complete as possible, according to our present records. It is based largely on material in the Canadian National Collection.

Trichoptilus pygmaeus Wlshm. Brit. Col.: Shawnigan, Vancouver Island.

Trichoptilus lobidactylus Fitch. Que.: Chelsea, Aylmer; Ont.: Ottawa, Severn; Alta.: Jasper.

Pterophorus periscelidactylus Fitch. Que.: Aylmer; Ont.: Ottawa, Pt. Pelee, Delhi, Walsh.

Pterophorus ontario McD. Ont.: Normandale.

Pterophorus evansi McD. Ont.: Trenton, Ottawa; Man.: Aweme.

Pterophorus tenuidactylus Fitch. Que.: Aylmer, Hemmingford, Kingsmere; Ont.: Ottawa, Caradoc, Sudbury, Cornwall, Centreville; Man.: Rounthwaite, Aweme; Alta.: Lethbridge, Waterton Lakes; Brit. Col.: Salmon Arm, Duncan, Burnaby.

Pterophorus raptor Meyr. Alta.: Waterton Lakes, Lethbridge.

Pterophorus delawaricus Zell. Alta.: Waterton Lakes; Brit. Col.: Keremeos, Barkerville, Goldstream, Kaslo, Anderson Lake, D'Arcy.

Platyptilia punctidactyla Haw. Ont.: Ottawa; Man.: Aweme, Rounthwaite; Alta.: Nordegg, Laggan, Lethbridge, Waterton Lakes; Brit Col.: Kaslo, Bio. Sta., Departure Bay, Salt Spr. Isd., Ucluelet.

Platyptilia pica Wlshm. Brit. Col.: Wellington, Victoria.

Platyptilia tesseradactyla Linn. Que.: Meach Lake, Aylmer; Ont.: Ottawa; Alta.: Moraine Lake, Waterton Lakes, Nordegg; Brit. Col.: Barkerville, Adams Lake.

Platyptilia carduidactyla Riley. Labrador, Hopedale; Que.: Pt. aux Alouettes; Alta.: Lethbridge; Sask.: Saskatoon, Indian Head; Brit. Col.: Kaslo, Osoyoos, Oliver, Salmon Arm, Vernon, Keremeos, Agassiz, Ucluelet, Bio. Sta., Departure Bay, Victoria, Vancouver.

Platyptilia percnodactyla Wlshm. Alta.: Waterton Lakes; Brit. Col.: Keremeos, Lillooet.

Platyptilia williamsi Grinnell. N. Brun.: Fredericton; Alta.: Nordegg.

Platyptilia albicans Fish. Alta.: Waterton Lakes.

Platyptilia pallidactyla Haw. Que.: Maniwaki; Ont.: Ottawa, Trenton, Orillia, Kearney; Man.: Aweme; Sask.: Last Mountain Lake, Craven.

Platyptilia ardua McD. Brit. Col.: Mt. McLean.

Platyptilia albertae B. &. L. Alta.: Banff; Brit. Col.: Revelstoke, Kaslo.

Platyptilia carolina Kearf. Que.: Hemmingford.

Platyptilia edwardsi Fish. Alta.: Rocky Mountain House, Banff, Moraine Lake, Waterton Lakes, Lethbridge; Brit. Col.: Mt. Cheam, Hedley, Mt. McLean, Lillooet, Keremeos.

Platyptilia orthocarpi Wlshm. Reported from Brit. Col. (G. O. Day), by Lindsey & Blackmore.

Platyptilia fragilis Wlshm. Brit. Col.: Seton Lake, Lillooet.

Platyptilia shastae Wlshm. Man.: Aweme; Alta.: Waterton Lakes; Brit. Col.: Oliver.

Platyptilia nana McD. Alta.: Waterton Lakes, Moraine Lake.

Platyptilia albiciliata var. *canadensis* McD. Alta.: Moraine Lake, Banff, Nordegg, Waterton Lakes; Brit. Col.: Marble Canyon, near Lillooet, Revelstoke, Aspen Grove, Ucluelet, Barkerville, Seton Lake, Lillooet.

Platyptilia albidorsella Wlshm. Alta.: Waterton Lakes.

Platyptilia maea B. & L. Alta.: Moraine Lake, Waterton Lakes, Banff.

Platyptilia modesta Wlshm. Man.: Aweme.

Platyptilia petrodactyla Wlk. Ponds Inlet, Baffin's Land.

Stenoptilia mengeli Fern. Reported from Mt. McLean, B.C., by Lindsey & Blackmore.

Pterophoridae—*Continued.*

Stenoptilia bowmani McD. ALTA.: Calgary, Nordegg.

Stenoptilia exclamationis Wlshm. BRIT. COL.: Ucluelet.

Stenoptilia coloradensis Fern. ONT.: Trenton, Ottawa; MAN.: Aweme; SASK.: Indian Head; ALTA.: Nordegg, Lethbridge, Jasper, Banff.

Stenoptilia columbia McD. ALTA.: Waterton Lakes, Moraine Lake; BRIT. COL.: Seton Lake, Lillooet.

Adaina montana Wlshm. ALTA.: Edmonton.

Adaina montana form *declivis* Meyr. ONT.: Ottawa, Trenton.

Adaina cinerascens Wlshm. ALTA.: Waterton Lakes.

Oidaematophorus occidentalis Wlshm. ALTA.: Waterton Lakes; BRIT. COL.: Keremeos, Oliver, Salmon Arm, Kaslo, Lillooet.

Oidaematophorus downesi McD. BRIT. COL.: Victoria.

Oidaematophorus mathewianus Zell. BRIT. COL.: Duncan, Victoria, Kaslo, Barkerville.

Oidaematophorus eupatorii Fern. QUE.: Chelsea; ONT.: Ottawa, Brockville, Trenton; MAN.: Aweme.

Oidaematophorus guttatus Wlshm. ALTA.: Waterton Lakes; BRIT. COL.: Seton Lake, Lillooet, Kaslo.

Oidaematophorus alaskensis B. & L. Described from Ramparts, Alaska, will probably occur in Yukon Terr.

Oidaematophorus grisescens Wlshm. ALTA.: Lethbridge; BRIT. COL.: Seton Lake, Lillooet, Kaslo.

Oidaematophorus cineraceus Fish. BRIT. COL.: Bio. Sta., Departure Bay.

Oidaematophorus rileyi Fern. ALTA.: Moraine Lake, Waterton Lakes; BRIT. COL.: Oliver.

Oidaematophorus lindseyi McD. MAN.: Aweme.

Oidaematophorus gratiosus Fish. ALTA.: Banff; BRIT. COL.: Barkerville.

Oidaematophorus brucei Fern. MAN.: Aweme; SASK.: Indian Head, Saskatoon; ALTA.: Nordegg; BRIT. COL.: Nicola.

Oidaematophorus inquinatus Zell. ONT.: Trenton; MAN.: Aweme; SASK.: Indian Head, Saskatoon.

Oidaematophorus fishi Fern. ONT.: Kearney; SASK.: Earl Grey; ALTA.: Nordegg, Banff; BRIT. COL.: Kaslo, Nicola, Mt. McLean, Lillooet, Oliver.

Oidaematophorus helianthi Wlshm. BRIT. COL.: Kaslo.

Oidaematophorus homodactylus Wlk. NOVA SCOTIA: Digby; QUE.: Chelsea, Kingsmere; ONT.: Mer Bleue, Ottawa, Trenton; MAN.: Aweme, Rounthwaite; ALTA.: Nordegg, Moraine Lake, Banff, Jasper, Waterton Lakes; BRIT. COL.: Lillooet.

Oidaematophorus elliotti Fern. QUE.: Chelsea, Aylmer.

Oidaematophorus stramineus Wlshm. QUE.: Ottawa Golf Club; ONT.: Trenton, Ottawa; MAN.: Rounthwaite, Aweme; SASK.: Saskatoon, Yorkton; ALTA.: McLeod, Nordegg, Waterton Lakes, Lethbridge, Moraine Lake; BRIT. COL.: Kaslo, Goldstream, Victoria.

Oidaematophorus lacteodactylus Cham. QUE.: Meach Lake; ONT.: Trenton, Toronto, Ottawa; MAN.: Aweme; SASK.: Indian Head, Craven, South Arm, Last Mountain Lake.

Oidaematophorus kellicotti Fish. ONT.: Ottawa, Trenton; MAN.: Aweme; SASK.: Last Mountain Lake; ALTA.: Edmonton.

Oidaematophorus sulphureodactylus Pack. SASK.: Indian Head.

Oidaematophorus costatus B. and L. BRIT. COL.: Nicola.

Oidaematophorus corvus B. and L. ALTA.: Nordegg, Rocky Mountain House, Banff, Waterton Lakes, Jasper; BRIT. COL.: Mt. McLean, Lillooet, Hedley, Kaslo, Salmon Arm.

Oidaematophorus perditus B. and L. MAN.: Aweme.

Oidaematophorus monodactylus Linn. ONT.: Trenton, Ottawa, Toronto, Guelph; MAN.: Rounthwaite, Aweme, Winnipeg; BRIT. CO.: Victoria, Vancouver, Mission, Oliver, Duncan.

Alucitidae

Alucita huebneri Wall. ONT.: Ottawa, Trenton; MAN.: Aweme; SASK.: Regina, Saskatoon; ALTA.: Lethbridge, Jasper; BRIT. COL.: Duncan, Victoria, Wellington, Strathcona.

Eucosmidae

The following list by Dr. J. McDunnough is the continuation and completion of the one begun in the 1924 Report and includes all the known Canadian species of the two remaining subfamilies of the Eucosmidae. As before, it is based on Heinrich's revision and the material in the Canadian National Collection.

Argyroplocinae

Episimus argutanus Clem. Ont.: Trenton, Ottawa, Severn; Man.: Aweme.
Bactra lanceolana Hbn. Reported by Heinrich from British Columbia.
Bactra furfurana Haw. Ont.: Ottawa.
Bactra verutana Zell. Ont.: Trenton; Alta.: Lethbridge.
Bactra maiorina Heinr. Man.: Aweme.
Polychrosis viteana Clem. Ont.: reported from the Niagara district.
Polychrosis cypripediana Forbes. Man.: Aweme.
Polychrosis yaracana Kft. Ont.: Ottawa, Orillia.
Polychrosis blandula Heinr. Man.: Aweme.
Ahmosia galbinea Heinr. Sask.: Saskatoon.
Ahmosia aspasiana McD. Ont.: Ottawa.
Endothenia montanana Kft. Ont.: Pt. Pelee.
Endothenia kingi McD. Sask.: Saskatoon, Indian Head.
Endothenia hebesana Wlk. Ont.: Ottawa, Trenton; Man.: Aweme. Alta.: Nordegg, Rocky Mountain House, Waterton.
Endothenia infuscata Heinr. Man.: Aweme.
Endothenia antiquana nubilana Clem. Que.: Island of Montreal; Ont.: Trenton; Man.: Aweme, Rounthwaite; Sask.: Indian Head, Regina; Alta.: Lethbridge, Calgary, Edmonton, Red Deer; Brit. Col.: Nicola, Oliver, Vancouver.
Taniva albolineana Kft. Ont.: Ottawa; Man.: Aweme; Alta.: Nordegg; Brit. Col.: Invermere.
Tia vulgana McD. Alta.: Nordegg.
Hulda impudens Wlshm. N.S.: Barrington Passage; Ont.: Ottawa; Man.: Aweme.
Esia approximana Heinr. Man.: Aweme.
Zomaria interruptolineana Fern. Recorded by Heinrich from Ontario.
Aphania capreana Hbn. Ont.: Ottawa, Trenton, Sudbury; Man.: Aweme, Sask.: Saskatoon; Alta.: Nordegg, Banff; Brit. Col.: Keremeos, Vancouver.
Aphania youngana McD. Que.: Meach Lake, Chelsea; Ont.: Ottawa, Hamilton.
Aphania frigidana Pack. N.W.T.: Artillery Lake, Great Slave Lake region.
Aphania tertiana McD. Ont.: Ottawa.
Aphania albeolana Zell. N.S.: Bridgetown.
Aphania apateticana McD Ont.: Ottawa.
Aphania deceptana Kft. Reported by Heinrich from Man., Sask., and Alta.
Aphania dextrana McD. Ont.: Ottawa; Man.: Aweme; Alta.: Calgary, Edmonton.
Aphania infida Heinr. Ont.: Ottawa, Trenton; Man.: Aweme, Brandon; Sask.: Indian Head; Alta.: Nordegg.
Aphania removana Kft. Que.: St. Therese Isl.; Ont.: Trenton; Sask.: Saskatoon; Alta.: Nordegg.
Sciaphila duplex Wlshm. Que.: Meach Lake; Ont.: Ottawa, Trenton; Man.: Aweme; Alta.: Waterton; Brit. Col.: Victoria.
Sciaphila duplex thallasana McD. Man.: Aweme, Lauder.
Badebecia urticana Hbn. Que.: Meach Lake, Chelsea; Ont.: Ottawa, Severn, Orillia; Man.: Aweme; Sask.: Regina; Alta.: Lethbridge, Waterton, Edmonton, Nordegg, Moraine Lake; Brit. Col.: Kaslo, Salmon Arm, Vernon, Keremos, Victoria, Ucluelet.
Exartema nitidanum Clem. Ont.: Ottawa.
Exartema furfuranum McD. Que.: Meach Lake; Ont.: Ottawa.
Exartema olivaceanum Fern. N.B.: Fredericton; Ont.: Ottawa, Orillia.
Exartema fraternanum McD. Ont.: Ottawa.
Exartema electrofuscum Heinr. Ont.: Severn; (one female ex larva on Sweet Fern.)
Exartema rusticanum McD. Man.: Onah.
Exartema zellarianum Fern. Ont.: Trenton.
Exartema atrodentanum Fern. Que.: Hemmingford; Ont.: Toronto.
Exartema punctanum Wlshm. Que.: St. Johns.
Exartema cornanum Heinr. Ont.: Ottawa.
Exartema inornatanum Clem. Reported by Heinrich from Quebec.
Exartema clavana Wlk. Reported by Heinrich from Quebec.
Exartema exoletum Zell. Que.: Aylmer, Chelsea; Ont.: Ottawa.
Exartema bicoloranum McD. N.S.: Barrington Passage.
Exartema quadrifidum Zell. Que.: St. Hilaire, Aylmer, Hemmingford, Montreal; Ont.: Ottawa; Man.: Aweme; Brit. Col.: Rockcreek.
Exartema nigranum Heinr. Que.: Chelsea, Aylmer; Ont.: Ottawa.
Exartema merrickanum Kft. Ont.: Ottawa.
Exartema corylanum Fern. Reported by Heinrich from Aweme, Manitoba.
Exartema sericoranum Wlshm. Reported by Heinrich from Quebec.
Exartema valdanum McD. Que.: Aylmer, Ft. Coulonge.
Exartema versicoloranum Clem. Ont.: Trenton.
Exartema brevirostranum Heinr. Man.: Aweme.
Exartema permundanum Clem. Que.: Meach Lake, Wakefield; Ont.: Ottawa, Trenton.
Exartema submissanum McD. Ont.: Ottawa.
Exartema nananum McD. Ont.: Mer Bleue, Ottawa.

Argyroplocinae—*Continued.*

Exartema appendiceum Zell. QUE.: Hudson, Meach Lake; ONT.: Ottawa; MAN.: Aweme.

Exartema concinnanum Clem. ONT.: Ottawa, Pt. Stanley.

Exartema concinnanum form *terminanum* McD. ONT.: Ottawa.

Exartema fasciatanum Clem. QUE.: Mt. St. Hilaire; ONT.: Ottawa, Trenton.

Exartema troglodanum McD. QUE.: Meach Lake; ONT.: Ottawa.

Hedia separatana Kft. ONT.: Ottawa, Putnam; MAN.: Aweme.

Hedia ochroleucana Hbn. N.S.: Bridgetown; ONT.: Ottawa, Trenton; MAN.: Aweme; SASK.: Indian Head; ALTA.: Edmonton, Lethbridge, Waterton; BRIT. COL.: Kaslo, Oliver, Keremeos, Vernon, Victoria, Sydney.

Hedia variegana Hbn. N.S.: Annapolis; BRIT. COL.: Agassiz.

Hedia chionosema Zell. QUE.: Aylmer; ONT.: Ottawa, Prescott, Guelph.

Hedia cyanana Murt. MAN.: Aweme.

Argyroploce auricapitana Wlshm. N.S.: Barrington Passage.

Argyroploce agilana Clem. QUE.: Laprairie; ONT.: Ottawa, Whitby, Niagara Glen, Putnam, Pt. Pelee.

Argyroploce albiciliana Fern. ONT.: Severn; MAN.: Aweme.

Argyroploce siderana chalybeana Wlshm. BRIT. COL.: Kaslo.

Argyroploce sordidana McD. ALTA.: Nordegg.

Argyroploce galaxana Kft. BRIT. COL.: Langford, Goldstream, Salmon Arm.

Argyroploce galaxana glitranana Kft. MAN.: AWEME; SASK.: Regina; ALTA.: Banff, Nordegg, Waterton; N.W.T.: Great Slave Lake region.

Argyroploce constellatana Zell. QUE.: Montreal, Chelsea; ONT.: Ottawa, Severn.

Argyroploce astrologana Zell. ONT.: Ottawa, Severn; MAN.: Aweme; SASK.: Indian Head, Regina; ALTA.: Calgary; BRIT. COL.: Kaslo, Salmon Arm.

Argyroploce coruscana Clem. ONT.: Pt. Pelee.

Argyroploce puncticostana Wlk. ONT.: Algonquin Park; ALTA.: Edmonton.

Argyroploce puncticostana major Wlshm. ALTA.: Banff, Nordegg.

Argyroploce deprecatoria Heinr. BRIT. COL.: Alta Lake, Mons, Wellington.

Argyroploce cespitana Hbn. QUE.: Meach Lake, St Johns; ONT.: Ottawa, Trenton, Severn; MAN.: Aweme; SASK.: Regina, Indian Head; ALTA.: Edmonton, Nordegg, Red Deer, Waterton, Moraine Lake, Banff; BRIT. COL.: Aspen Grove, Kaslo.

Argyroploce carolana McD. ONT.: Ottawa, Lyn, Trenton; ALTA.: Waterton.

Argyroploce polluxana McD. ONT.: Ottawa, Mer Bleue; ALTA.: Nordegg, Moraine Lake, Banff.

Argyroploce glaciana Moesch. LABR.: Hopedale; N.S.: Barrington Passage; QUE.: Meach Lake; ONT.: Ottawa, Severn; MAN.: Aweme; ALTA.: Edmonton, Nordegg, Calgary, Waterton; BRIT. COL.: Salmon Arm; N. W. TERR.: Great Slave Lake region.

Argyroploce bipartitana Clem. QUE.: Meach Lake; ONT.: Ottawa, Trenton, Toronto, Orillia, Severn, Pt. Pelee; MAN.: Aweme; ALTA.: Nordegg, Waterton, Calgary; BRIT. COL.: Chilcotin.

Argyroploce heinrichana McD. LABR.: Hopedale.

Argyroploce nordeggana McD. ALTA.: Nordegg.

Argyroploce schulziana Fabr. QUE.: Rocky Bay, Bonne Esperance, Bradore; ALTA.: Nordegg; BRIT. COL.: Windermere.

Argyroploce intermistana Clem. LABR.: Hopedale; N.S.: Barrington Passage; ALTA.: Laggan; N. W. TERR.: Great Slave Lake region.

Argyroploce septentrionana Curt. LABR.: Hopedale.

Argyroploce inquietana Wlk. N. W. TERR.: Bernard Harbor.

Argyroploce bowmanana McD. ALTA.: Nordegg, Moraine Lake.

Argryoploce mengelana Fern. N. W. TERR.: Netilling Lake, Baffin Land.

Argyroploce costimaculana Fern. LABR.: Hopedale; N.S.: Barrington Passage; QUE.: Meach Lake; ONT.: Ottawa, Kearney; ALTA.: High River.

Argyroploce buckellana McD. BRIT. COL.: Salmon Arm.

Argyroploce buckellana albidula Heinr. ONT.: Ottawa; MAN.: Aweme; SASK.: Saskatoon, Indian Head.

Evora hemidesma Zell. ONT.: Ottawa, Algonquin Park; MAN.: Aweme.

Laspeyresiinae

Dicrorampha kana Bsk. ALTA.: Banff, Moraine Lake, Waterton; BRIT. COL.: Salmon Arm, Mt. Cheam, Oliver.

Dichrorampha britana Bsk. ALTA.: Hillcrest; BRIT. COL.: Kaslo.

Dichrorampha simulana Clem. QUE.: Meach Lake; ONT.: Ottawa.

Dichrorampha sedatana Bsk. ALTA.: Waterton.

Dichrorampha dana Kft. QUE.: Meach Lake, Cascades; ONT.: Ottawa.

Dichrorampha leopardana Bsk. Reported by Heinrich from Ontario.

Hemimene felicitana Heinr. ONT.: Pt. Pelee.

Hemimene signifera Heinr. ONT.: Lake of Bays.

Hemimene paula Heinr. MAN.: Aweme.

Sereda lautana Clem. QUE.: Aylmer; MAN.: Aweme.

Laspeyresiinae—*Continued*

Grapholitha molesta Bsk. Ont.: Vineland.

Grapholitha libertina Heinr. Described from Wellington, B.C.

Grapholita prunivora Wlshm. Que.: Meach Lake; Ont.: Ottawa, Orillia, Severn, Chatham; Alta.: Waterton.

Grapholitha angleseana Kft. Ont.: Pt. Pelee.

Grapholitha caeruleana Wlshm. Brit. Col.: Langford, Saanich dist.

Grapholitha conversana Wlshm. Brit. Col.: Oliver.

Grapholitha imitativa Heinr. Alta.: Waterton; Brit. Col.: Salmon Arm.

Grapholitha lunatana Wlshm. Man.: Aweme; Alta.: Wabamun, Edmonton; Brit. Col.: Kaslo, Victoria, Saanich district.

Grapholitha interstinctana Clem. Que.: Meach Lake; Ont.: Ottawa, Cornwall; Alta.: Nordegg, Waterton.

Grapholitha lana Kft. Reported by Heinrich from Wellington and Goldstream, B.C.

Grapholitha tristrigana Clem. Ont.: Pt. Pelee, Toronto, London.

Laspeyresia rana Forbes. Ont.: Ottawa; Alta.: Nordegg.

Laspeyresia obnisa Heinr. Described from Fraser Mills, B.C.

Laspeyresia garacana Kft. Recorded from Trenton, Ont.

Laspeyresia multilineana Kft. Man.: Aweme; Alta.: Edmonton.

Laspeyresia ingrata Heinr. Described from Aweme, Man.

Laspeyresia albimaculana Fern. Ont.: Mer Bleue, Ottawa, Niagara Glen.

Laspeyresia populana Bsk. Ont.: Ottawa, Trenton; Man.: Aweme; Alta.: Nordegg, Lethbridge.

Laspeyresia youngana Kft. Ont.: Ottawa; Man.: Aweme.

Laspeyresia nigricana Steph. N.S.: Truro; Man.: Brandon; Alta.: Nordegg.

Laspeyresia fletcherana Kft. Ont.: Ottawa.

Laspeyresia prosperana Kft. Alta.: Waterton, Hillcrest; Brit. Col.: Kaslo, Hedley, Goldstream, Malahat.

Laspeyresia lautiuscula Heinr. Described from Fraser Mills, B.C.

Laspeyresia flexiloqua Heinr. Alta.: Calgary.

Laspeyresia americana Wlshm. Recorded by Heinrich from B.C.

Laspeyresia miscitata Heinr. Brit. Col.: "Interior."

Melissopus latiferreanus Wlshm. Ont.: Trenton.

Carpocapsa pomonella Linn. Que.: Hemmingford; Ont.: Ottawa, Vineland; Brit. Col.: Kaslo, Kamloops.

Ecdytolopha insiticiana Zell. Ont.: Trenton.

Coleoptera

(Arranged according to Leng's Catalogue of Coleoptera, 1920)

Cicindelidae

74 *Cicindela punctulata* Oliv. Medicine Hat, Alta., (F. S. Carr).

Carabidae

115 *Trachypachus inermis* Mots. Edmonton, Alta., (Carr).
439 *Bembidion obliquulum* Lec. Medicine Hat, Alta., (Carr).
487 *Bembidion planiusculum* Mann. Edmonton, Alta., (Carr).
503 *Bembidion breve* Mots. Edmonton, Alta., (Carr).
514 *Bembidion quadrulum* Lec. Pincher, Alta., (Carr).
560 *Bembidion nitens* Lec. Edmonton, Alta., (Carr).
661 *Bembidion obtusangulum* Lec. Medicine Hat, Alta., (Carr).
* *Bembidion yukonum* Fall. Dawson, Y.T., (Fall).
695 *Bembidion constrictum* Lec. Dundern, Sask., (Criddle).
721 *Bembidion timidum* Lec. Edmonton and Pincher, Alta., (Carr).
726 *Bembidion scudderi* Lec. Medicine Hat, Alta., (Carr).
Bembidion obtusidens Fall. Dundern, Sask., (Criddle); Winnipegosis, Man., (Wallis and E. Criddle).
730 *Bembidion oberthüri* Hayd. Edmonton, Alta., (Carr).
732 *Bembidion aenicolle* Lec. Edmonton, Alta., (Carr).
741 *Bembidion dubitans* Lec. (Edmonton and Medicine Hat, Alta., (Carr).
754 *Bembidion sulcatum* Lec. Edmonton, Alta., (Carr).
* *Bembidion lachnophoides* Darl. Medicine Hat, Alta., (Carr). Psyche, Vol. XXXIII, 1926.
1153 *Poecilus scitulus* Lec. Medicine Hat, Alta., (Carr).
1483 *Calathus ingratus* Dej. Cypress Hills, Alta., (Carr).
1499 *Rhadine dissecta* Lec. Castor, Alta., (Carr).
1650 *Lebia divisa* Lec. Transcona, Man., (S. Brooks).
1747 *Cymindis borealis* Lec. Tofield, Alta., (Carr).
Chlaenius frosti Carr. Cypress Hills, Alta., (Carr).
Chalenius albertinus Csy. Cypress Hills, Alta., (Carr).

Dytiscidae

* *Coelambus borealis* Fall. Dawson, Y.T., (Fall).
Hydroporus planiusculus Fall. Cypress Hills, and Medicine Hat, Alta., Michel, B.C., (Carr).
* *Hydroporus yukonensis* Fall. Dawson, Y.T., (Fall); Jasper, Alta., (F. Neave).
* *Hydroporus alaskanus* Fall. Keremeos, B.C., (Criddle).
2568 *Agabus obliteratus* Lec. Medicine Hat, Cypress Hills and Pincher, Alta., (Carr).
2589 *Ilybius subaeneus* Er. Aweme East, Man., (Wallis); Lytton, B.C., (Auden).
2597 *Ilybius discedens* Shp. Aweme and Riding Mts., Man., (Wallis and E. Criddle).

Gyrinidae

2692 *Gyrinus aquiris* Lec. Husavick, Man., (Wallis).

Staphylinidae

* *Stenus frigidus* Fall. Edmonton, Alta.
* *Philonthus septentrionis* Fall. Dawson, Y.T., (Fall).
Philonthus fraternus Fall. Dawson, Y.T., (Fall).

Histeridae

6530 *Hololepta aequalis* Say. Medicine Hat, Alta., on Cottonwood, (Carr).

Lampyridae

6977 *Lucidota fenestralis* Melsh. Medicine Hat, Alta., (Carr).

Cantharidae

* *Podabrus fissilis* Fall. Emerald Lake, B.C., (A. Fenyes).
7074 *Podabrus puncticollis* Kby. Onah and Husavick, Man., (Wallis).
7100 *Cantharis nigritulus* Lec. Victoria Beach, Man., (Wallis).

Melyridae

7208 *Collops bipunctatus* Say. Medicine Hat, Alta., (Carr).
7217 *Collops punctulatus* Lec. Medicine Hat, Alta., (Carr).

Pedilidae

8263 *Pergetus campanulatus* Lec. Medicine Hat, Pincher and Edmonton, Alta., (Carr).

Anthicidae

8315 *Notoxus cavicornis* Lec. Medicine Hat, Alta., (Carr).
8389 *Anthicus scenicus* Csy. Saskatoon, Sask., (King); Edmonton, Alta., (Carr).
8401 *Anthicus flavicans* Lec. Medicine Hat, Alta., (Carr).
8407 *Anthicus hastatus* Csy. Medicine Hat, Alta., (Carr).
8411 *Anthicus coracinus* Lec. Edmonton, Alta., (Carr).

Elateridae

8710 *Ludius fusculus* Lec. Medicine Hat, Alta., (Carr).
8818 *Cryptohypnus planatus* Esch. Pincher, Alta., (Carr).
8839 *Hypnoidus dispersus* Horn. Pincher, Alta.
8849 *Hypnoidus pectoralis* Say. Pincher, Alta.
8960 *Elater pedalis deletus* Lec. Victoria Beach, Man., (Wallis).
9094 *Cardiophorus pubescens* Blan. Medicine Hat, Alta., (Carr).

Buprestidae

9272 *Acmaeodera pulchella* Herbst. Medicine Hat, Alta., (Carr).
9376 *Buprestis confluenta* Say. Medicine Hat, Alta., (Carr).
9522 *Agrilus cephalicus* Lec. Medicine Hat, Alta., (Carr).

Dascillidae

9679 *Eucinetus testaceus* Lec. Victoria Beach, Man., (Wallis).

Dermestidae

* *Trogoderma sinistra* Fall. Dawson, Y.T., (Fall).
9835 *Anthrenus verbasci* varius Fab. Winnipeg, Man., (Wallis).

Cucujidae

10261 *Laemophloeus pusillus* Schön. Winnipeg, Man., (Wallis).

Coccinellidae

11158 *Ceratomegilla fuscilabris* Muls. Winnipeg, Man., (Wallis).
11183 *Coccinella tricuspis* Kby. Cypress Hills, Alta., (Carr).
Chilocorus fraternus Lec. Cypress Hills, Alta., (Carr).

Bostrichidae
12908 *Stephanopachys substriatus* Payk. Medicine Hat, Alta., (Carr).

Scarabaeidae
13345 *Trox atrox* Lec. Medicine Hat, Alta., (Carr).

Cerambycidae
* *Tetropium alaskanum* Fall. Dawson, Y.T., (Fall).

Chrysomelidae
15213 *Donacia pusilla* Say. Cypress Hills, Alta., (Carr).
15233 *Zeugophora varians* Cr. Medicine Hat, Alta., (Carr).
15493 *Cryptocephalus confluens* Say. Medicine Hat, Alta., (Carr).
15499 *Cryptocephalus insertus* Hald. Medicine Hat, Alta., (Carr).
Phytodecta notmani Schaef. Cypress Hills, Alta., "on willow only" (Carr).
15734 *Trirhabda attenuata* Say. Medicine Hat, Alta., "on sage brush only" (Carr).
Disonycha latifrons Schaef. Medicine Hat, and Pincher, Alta., (Carr).
16010 *Chaetocnema opulenta* Horn. Medicine Hat, Alta., (Carr).
16148c *Jonthonota novemmaculata* Mann. Medicine Hat, Alta., (Carr).

Mylabridae
16175 *Mylabris discoideus* Say. Medicine Hat, Alta., (Carr).

Curculionidae
16336 *Auletes congruus* Walk. Medicine Hat, Alta., (Carr).
16620 *Evotus naso* Lec. Medicine Hat and Edmonton, Alta., (Carr).
16762 *Phytonomus castor* Lec. Cypress Hills, Alta., (Carr).
18103 *Sphenophorus ochreus* Lec. Medicine Hat, Alta., (Carr).

Scolytidae
* *Hylastes yukonis* Fall. White Horse and Dawson, Y.T., (Fall).
All the new species listed above under Fall were described in the Pan-Pacific Entomologist, Vols. II and III, 1926.

DIPTERA

Prepared by C. H. Curran

Species described as new in the Canadian Entomologist during the year 1926 are omitted from the record. The number given before the name of a species refers to the page in Aldrich's "catalogue" on which the name of the genus appears.

Tipulidae
*59 *Limnophila auripennis* Alexander. Orillia, Ont., June 10, (Curran).
* *Limnophila platyphallus* Alexander. Orillia, Ont., June 10, (Curran).
The above two species described in Bull. Brook. Ent. Soc. XXI, 111-113.

* *Limnophila harperi* Alexander. Athabasca Delta, Alta., June 18, (F. Harper).
* *Limnophila mc-dunnoughi* Alexander. Nordegg, Alta., July 14, (J. McDunnough).
* *Ormosia garretti* Alexander. Banff, Alta., July, 1922, (C. Garrett).
* *Ormosia hubbelli* Alexander. Aweme, Man., Aug. 15, (N. Criddle).
The above four species described in Ins. Ins. Menst., XIV. 19-23.

*92 *Dicranota currani* Alexander. Ottawa, Ont., Hull, Que., May 9, 1923-1924. (Curran).
*99 *Tipula parvemarginata* Alexander. Portage la Prairie, Man., July, (A. J. Hunter).
The above two species described in Ent. News, XXXVII.

* *Tipula perparvula* Alexander. Aweme, Man., June 29, (Criddle).
Described in Ins. Ins. Menst., XIV, 120.

Psychodidae
*105 *Pericoma aldrichana* Dyar. Anchorage, Alaska, June 15, (J. M. Aldrich).

Culicidae
121 *Anopheles maculipennis* Meigen. Indian Head, Sask., (E. Hearle).
Culiceta dyari Coq. Odessa, Sask., (Hearle).
126 *Culex apicalis* Ad. Indian Head, Sask., (Hearle).
134 *Aedes nigromaculis* Lud. Indian Head, Sask., (Hearle).

Cecidomyidae
156 *Asphondylia helianthiflorae* Felt. Montreal, Quebec, Oct. 18-27, 1926, (A. F. Winn). On *Helianthus decapetalus*.

Simulidae
168 *Simulium forbesi* Mall. Aweme, Man., July, on crow, (N. Criddle).

Blephariceridae
171 *Bibiocephala grandis* O. S. Seton Lake, B.C., May 31, (McDunnough).

Stratiomyidae
* *Beris annulifera brunnipes* Johnson. Labrador.
* *Beris annulifera luteipes* Johnson. Kearney and Lake Nipigon, Ont.
The above described in Psyche, XXXIII, 109.

Tabanidae
*195 *Chrysops wiedemanni* Krober. Quebec and Ontario.
* *Chrysops canadensis* Krober. Mer Bleu, Ottawa, Ont., June 7, 1925, (Curran).
* *Chrysops pilumnus* Krober. Jordan, Ont., June 21, 1917, (W. A. Ross).
* *Chrysops moerens confusus* Krober. Oliver, B.C., Aug. 13, 1923, (C. Garrett).
* *Chrysops geminatus impunctus* Krober. Port Stanley, Ont., June 25, (C. R. Twinn).
* *Chrysops ornatus* Krober. Jordan, Ont., July 17.
The above described in Stett. Ent. Zeit., for 1926.

Chrysops fuliginosus Wiedemann. Kings Co., N.S., July.

Bombyliidae
Anthrax pauper Loew. Seton Lake, B.C., June, (McDunnough).
Villa sabina O.S. Seton Lake, B.C., June, (McDunnough).
Villa gracilis Meig. Carcross, Yukon, Aug., (Mrs. T. D. A. Cockerell).
Villa molitor Loew. Carcross, Yukon, Aug., (Mrs. T. D. A. Cockerell).
Villa aggripina O.S. Seton Lake, B.C., June, (McDunnough).
235 *Bombylius albocapillus* Loew. Medicine Hat, Alta., April, (F. S. Carr).

Therevidae
246 *Psilocephala limata* Coq. Waterton, Alta., July, (H. L. Seamans).
Psilocephala signatipennis Cole. Oliver, B.C., July, (E. R. Buckell).
Psilocephala baccata Coq. Aweme, Man., May, (N. Criddle, R. M. White); Medicine Hat, Alta., May, (F. S. Carr).
Psilocephala albertensis Cole. Aweme, Man., June, (N. Criddle and R. M. White).
Dialineura crassicornis Will. Duncan, B.C., June, (W. Downes).
247 *Thereva johnsoni* Coq. Saanich District, B.C., July 24, (W. Downes).
Thereva flavicincta Loew. Aylmer, Que., July, (H. L. Viereck); Burkes Falls, Ont., July, (F. Ide).
Thereva strigipes Loew. Macdiarmid, Ont., July, (N. K. Bigelow).

Asilidae
253 *Leptogaster hirtipes* Coq. Seton Lake, B.C., July 6, (McDunnough).
Leptogaster aridus Cole. Seton Lake, Lillooet, B.C., June 15, (McDunnough); Vernon, B.C., July, (N. L. Cutler).
260 *Lasiopogon quadrivittatus* Jones. Medicine Hat, Alta., May 8, (F. S. Carr).
Lasiopogon aldrichi Mel. Banff, Alta., July, (C. Garrett).
Lasiopogon cinereous Cole. Frank, Alta., Aug. 15, (E. H. Strickland).
Buckellia (Cophura) brevicornis Will. Seton Lake, Lillooet, B.C., June, July, (McDunnough).
266 *Nicocles punctipennis* Mel. Medicine Hat. Alta., April 24, (F. S. (Carr).
275 *Erax subcupreus* Schiner. Medicine Hat, Alta., June, (F. S. Carr).
282 *Asilus coquilletti* Hine. Seton Lake and Anderson Lake, B.C., June, (McDunnough).

Dolichopodidae
288 *Diaphorus adustus* Van Duzee. Nyarling River, N.W.T., July, (J. Russell).
292 *Rhaphium crassipes* Meigen. Alta Lake, Mons, B.C., June 10, (McDunnough).
Rhaphium campestre Curran, Allan, Sask., Aug., (K. M. King).
293 *Neurigona carbonifera* Loew. Orillia, Ont., June 27, 29, (Curran); Niagara Glen, Ont., June 23, (G. S. Walley).
Neurigona deformis Van Duzee. Orillia, Ont., June 26, 28, (Curran).
Neurigona pectoralis Van Duzee. Niagara Glen, Ont., June, July, (G. S. Walley).
Neurigona aestiva Van Duzee. Tillsonburg, Ont., June 4, Niagara Glen, Ont., June 23, (Walley).
Neurigona planipes Van Duzee. Seton Lake, Lillooet, B.C., June 9, (McDonnough).
*295 *Thinophilus spinipes* Van Duzee. Baldur, Man., (N. Criddle).
This species described in Ann. Ent. Soc. Am., XIX, 46.

Thinophilus fulvidorsum Van Duzee. Nyarling River, N.W.T., July, (J. Russell).
295 *Medetera halteralis* Van Duzee. Laprairie, Que., July, (F. Ide).

Dolichopodidae—*Continued.*
296 *Hydrophorus philombrius* Wheeler. Orillia, Ont., June, (Curran).
Hydrophorus fumipennis Van Duzee. Nettilling Lake, Baffin Land, May 30, (J.D. Soper).
Hydrophorus claripennis Van Duzee. Saskatoon, Sask., May, (K. M. King).
Hydrophorus purus Curran. Richdale, Alta., Aug., (K. M. King).
Hydrophorus cerutias Loew. Richdale, Alta., Aug. 22, (K. M. King).
* *Hydrophorus albomaculatus* Van Duzee. Aweme, Man., July 12, (R. D. Bird).
* *Hydrophorus argentifacies* Van Duzee. Treesbank, Man., Sept. 16, April 16, (N. Criddle).
* *Hydrophorus flavipennis* Van Duzee. Wainfleet, Ont., July 20, (M. C. Van Duzee).
* *Hydrophorus lividipes* Van Duzee. Aweme, Man., April 8, (N. Criddle).
* *Hydrophorus nigrinervis* Van Duzee. Kamloops, B.C., July 30, (N. Criddle).

The above five species described in Psyche, XXXIII, 46-51.

298 *Dolichopus pernix* Mel. & Br. Cypress Hills, Sask., June, (C. H. Young).
Dolichopus virga Coq. Severn, Ont., July, (Curran).
Dolichopus indigina Van Duzee. Teulon, Man., Aug. 5, (A. J. Hunter).
Dolichopus conspectus Van Duzee. Baldur, Man., June, (R. M. White).
Dolichopus uxorcula Van Duzee, Victoria Beach, Man., Sept., (N. Criddle).
Dolichopus nigricornis Meigen (*discifer* Stann), Alta Lake, B.C., June 11, (McDunnough).
Dolichopus maculitarsis Van Duzee, Nyarling River, N.W.T., July, (J. Russell).
Dolichopus nigricauda Van Duzee, Nyarling River, N.W.T., July, (J. Russell).
306 *Hercostomus unicolor* Loew, Saskatoon, Sask., July, (K. M. King).

Syrphidae
344 *Microdon Champlaini* Curran, Orillia, Ont., June 28, Severn, Ont., July 3, (Curran).
Microdon albipilis Curran. Lethbridge, Alta., Aug., (E. R. Tinkham).
347 *Chrysotoxum perplexum* Johnson. Transcona, Man., Sept., (G. S. Brooks).
363 *Syrphus attenuatus* Hine. Carcross, Yukon, Aug., (Mrs. T. D. A. Cockerell).
Syrphus limatus Hine. Atlin, B.C., Aug., (Mrs. T. D. A. Cockerell).
Syrphus perplexus Osb. White Horse, Yukon, Aug., (Mrs. T. D. A. Cockerell).
360 *Melanostoma kelloggi* Snow. Mt. McLean, B.C., July 12, (E. R. Buckell).
358 *Pyrophaena granditarsis* Forst. Nyarling River, N.W.T., July, (J. Russell).
Cartosyrphus plumosa Coq., Bearberry Creek, Sask., July 23, (C. H. Young).
Cartosyrphus sororcula Will. Cypress Hills, Sask., June 26, (C. H. Young).
351 *Chilosia ferruginea* Lov. Cypress Hills, Alta., May, (F. S. Carr).
Chilosia nigroapicata Curran. Cypress Hills, Alta., May, (Carr).
348 *Chrysogaster sinuosa* Bigot. Seton Lake, Lillooet, B.C., June 5, (McDunnough).
Chrysogaster nigripennis Will. Alta Lake, Mons, B.C., June 2, (McDunnough).
394 *Asemosyrphus willingi* Smith. Baldur, Man., July, (G. S. Brooks); Nyarling River, N.W.T., July, (J. Russell).
400 *Brachypalpus parvus* Will. Pincher, Alta., May, (Carr).
397 *Xylota bicolor* Loew. Niagara Glen, Ont., June 23, (G. S. Walley).
Xylota florum Fabr. Nyarling River, N.W.T., July, (J. Russell).
* *Xylota confusa* Shannon, . B.C.
* *Xylotomima nemorum americanum* Shann. Kaslo, B.C.

Both the above described in Proc. U.S.N.M., lxix, Art. 9.

Conopidae
410 *Zodion obliquefasciata* Macq. Beaver Creek, Sask., July, (N. J. Atkinson).
412 *Myopa vesiculosa varians* Banks. McLeod, Alta., May, Irvine, Alta., May, (Carr).

Trypaneidae
608 *Eutreta diana* O.S. Seton Lake, Lillooet, B.C., June, (McDunnough); Medicine Hat, Alta., Aug. 24, (Criddle).
Eutreta longicornis Snow, Medicine Hat, Alta., June 20, (Carr).
608 *Carphotricha culta* Coq. Pincher, Alta., May 2, (Carr).

Ephydridae
629 *Ephydra obscuripes* Loew. Seton Lake, Lillooet, B.C., June, (J. McDunnough).
630 *Scatella palludum* Meigen. Cape Prince of Wales, Alaska, June, (D. Jenness).

Micropezidae
*615 *Micropeza lineata* V.D. Aweme, Man., June, (Criddle); Winnipeg, Man., July, (J. Fletcher); Orion, Alta., Aug., (H. L. Seamans).

Described in Pan. Pac. Ent., iii, 2, 1926.

Micropeza turcana Townsend. Aweme, Man., June, (Criddle); Lethbridge, Alta., June, G. A. Mail).
616 *Calobata mima* Cress. Triangle, Sask., July, (N. J. Atkinson).
* *Calobata kennicotti* Banks. "Huds. Bay Terr."
Psyche, xxxiii, 43.

Scatophagidae
567 *Microprosopa lineata* Zett. Cape Prince of Wales, Alaska, June, (D. Jenness).

Muscidae
551 *Hydrophoria alaskensis* Mall. Nettilling Lake, Baffin Land., July, (J. D. Soper).
Hydrophoria elongata Mall. Baldur, Man., July, (G. S. Brooks); Cypress Hills, Sask., July, (C. H. Young).
Hydrophoria ambigua Meig. Baldur, Man., July 19, (Brooks).
554 *Eremomyia incompleta* Stein. Medicine Hat, Alta., March, April, (Carr).
Eremomyoides setcsa Stein. Medicine Hat, Alta., April, (Carr).
*534 *Hydrotaea abdominalis* Aldrich. Kaslo, B.C.

Proc. U.S.N.M., lxix, Art. 22.

Alliposis obesa Mall. Nettilling Lake, Baffin Land, July, (J. D. Soper).
Helina latifrontata Mall. Teulon, Man., July, (A. J. Hunter).
Helina nasoni Mall. Cypress Hills, Sask., July, (C. H. Young).
Helina bispinosa Mall. Stormy Mt., Man., Aug., (A. J. Hunter).
Hebecnema affinis Mall. Burkes Falls, Ont., July, (F. Ide).
546 *Limnophora leucogaster* Zett. Stormy Mt., Man., Aug., (A. J. Hunter).
542 *Trichopticus diffinis* Mall. Riding Mts., Man., July, (G. S. Brooks).
560 *Coenosia lata* Walker. Cypress Hills, Alta., May, (Carr).

Calliphoridae
Steringomyia montana Shann. Edmonton, Alta., Aug., (E. H. Strickland).

Sarcophagidae
Emblamasoma erro Aldrich. Seton Lake, Lillooet, B.C., June, (McDunnough).
510 *Sarcophaga eleodis* Ald. Seton Lake, Lillooet, B.C., June, (McDunnough).
* *Eumacronychia elongata* Allen. Glenboro, Man., June, (H. A. Robertson).
* *Metopia opaca* Allen. Ottawa, Ont., July 26, (Curran).
* *Pachyophthalmus distortus* Allen. Barber Dam, New Brunswick, June, (J. D. Tothill); Muskrat Falls, Labr., July, (S. E. Arthur); Kaslo, B.C., (Currie).
* *Phrosinella aldrichi* Allen. Oliver, B.C., June 7, (C. Garrett).
* *Phrosinella pilosifrons* Allen. Lillooet, B.C., July, (J. D. Tothill); Penticton, B.C., June, (W. B. Anderson); Victoria, B.C., July, (W. Downes).

The above species described in Proc. U.S.N.M., lxviii, Art. 9.

Tachinidae
426 *Myiophasia clistoides* Towns. Stony Mt., Man., Aug., (J. B. Wallis).
* *Cylindromyia compressa* Ald. Banff, Alta., (C. Garrett).
* *Cylindromyia vulgaris* Ald. Victoria, William Head, Saanich District, (Downes); Vernon, (N. L. Cutler); Oliver, (P. N. Vroom, E. R. Buckell); Penticton, (R. C. Treherne); Lillooet, (W. B. Anderson) All localities in B.C.

The preceding two species described in Proc U.S.N.M., lxciii, Art. 23.

* *Cryptomeigenia muscoidea* Curran. Aweme, Man., (Criddle); Teulon, Man., May, (A. J. Hunter); Orillia, Ont., June, (Curran).
* *Cryptomeigenia ontario* Curran. Belleville, Ont., (Evans); Chatham, Ont., (Walley); Mer Bleu, Ottawa, (R. H. Ozburn); Hull and Aylmer, Que., (Curran); Aweme, Man., (H. A. Robertson). May and June.
* *Cryptomeigenia triangularis* Curran. Fredericton, N.B., May, (L. S. McLaine); Aylmer, Que., May, June, (C. B. Hutchings); Fairy Lake, near Hull, Que.; Teulon, Man., June, (Hunter); Aweme, Man., June, (H. A. Robertson).
* *Cryptomeigenia nigripilosa* Curran. Lillooet, B.C., June, (J. D. Tothill).
* *Cryptomeigenia nigripes* Curran. Bothwell, Ont., June, (Walley).
* *Cryptomeigenia simplex*, Curran. Hull and Aylmer, Que., May, (Curran).
* *Cryptomeigenia dubia* Curran. Point Pelee, Ont., June, (Walley).
* *Cryptomeigenia ochreigaster* Curran. Aweme, Man., May, (R. M. White); Winnipeg, Man., June, (F. B. Fetterman).
* *Tachinomyia variata* Curran. Ont., Que., Man., Alta.
* *Tachinomyia apicata* Curran. Que., Ont., Man., B.C., N.S.
* *Tachinomyia occidentalis* Curran. B.C., Man.

The above species described in Trans. Royal Soc. Can., Sec. V, 1926.

* *Ursophyto rufigena* Aldrich. Eberts, B.C., June 19, 1914, (R. H. Chrystal).
Described in Proc. U.S.N.M., lxix, Art. 22, 14.

Pseudotachinomyia webberi Smith. Medicine Hat, Alta., April, (Carr).
Dexodes aurifrons Coq. Low Bush, Lake Abitibi, Ont., Aug., (N. K. Bigelow).
Lydella polita Towns. Seton Lake, Lillooet, B.C., June, (McDunnough).
462 *Frontina spectabilis* Aldrich. Seton Lake, Lillooet, B.C., July, (McDunnough).
464 *Sturmia bakeri* Coq. Cypress Hills, Sask., July, (C. H. Young).
Zenillia submissa A. & W. Cameron Lake, Alta., Aug., (K. M. King).

Hymenoptera

Ichneumonidae

* *Campoplegidea totalis* Vier. Aylmer, Que., Aug., (A. R. Graham).
* *Campoplegidea fuscitarse* Vier. Ottawa, (Harrington).
* *Campoplegidea mimeticus* Vier. Rigaud and Montreal, Que., (J. Beaulieu); Hull, Que., (Harrington); Jordon, Ont., (W. A. Ross).
* *Campoplegidea subtilis* Vier. Banff, Alta., (Garrett).
* *Campoplegidea woodi* Vier. Coldstream, Ont., (A. A. Wood).
* *Campoplegidea erythromera* Vier. Ottawa, Ont., (Harrington).
* *Campoplegidea erythrosoma* Vier. Montreal, Que., Ottawa, Ont., (Harrington).
* *Campoplegidea nigritibialis* Vier. Victoria, B.C., (W. Downes).
* *Campoplegidea curvata* Vier. Sudbury, Ont., (Evans).
* *Campoplegidea sessilis* Vier. Montreal, Que.
* *Campoplegidea citripes* Vier. Lanoraie, Que., (J. I. Beaulne).
* *Campoplegidea flavicoxa* Vier. Montreal, Que., (Beaulieu).
* *Campoplegidea varicoxa* Vier. Sudbury, Ont., (Evans).
* *Campoplegidea montrealensis* Vier. Montreal, Que.
* *Campoplegidea reticulata* Vier. Royal Oak, B.C., (W. Downes).
* *Campoctonus fossatus* Vier. Aweme, Man., (P. N. Vroom).
* *Pseudocasinaria paenealia* Vier. Sudbury, Ont.
* *Pseudocasinaria decorata* Vier. Ottawa, Ont., (Harrington).
* *Amorphota pacifica* Vier. Victoria, B.C., (Downes).
* *Amorphota bicoloripes* Vier. Aweme, Man., (Criddle).
* *Idechthis mimicus* Vier. Georgetown, Ont.

The above species described in Trans. Royal Soc. Can., Sec. V, 1926.

* *Syzeuctus sigmoidalis* Cush. Godbout, Que., (E. M. Walker). Proc. U.S. Nat. Mus., Vol. 67, 1926.

Calliceratidae

* *Aparamesius nigriclavis* Fouts. Toronto, Ont., (H. S. Parish). Proc. Ent. Soc. Wash., Vol. 28, No. 8, 1926.

Megachilidae

* *Anthidium tenuiflorae yukonense* Cockrl. Carcross, Yukon Territory, (W. P. Cockerell). Ann. Mag. Nat. Hist., XVIII, No. 108, 1926.

Apidae

* *Bremus rufocinctus sladeni* Frison. Ottawa, Ont., (F. W. L. Sladen).
* *Bremus pleuralis clarus* Frison. Fort Wringley, N.W.T., (C. H. Crickmay). Laggan, B.C.

The above two races described in Trans. Am. Ent. Soc., Vol. LII, No. 2, 1926.

Hemiptera

Coreidae

Leptoglossus fulvicornis Westw. Jordan, Ont., 30, VI, 17. (W. A. Ross).
Chelinidea vittiger Uhl. Medicine Hat, Alta., 2 V, 25, (F. S. Carr). on cactus. (The Quebec record of Provancher is considered doubtful.)

Lygaeidae

Oncopeltus fasciatus Dall. Caradoc, Ont., 15, VIII, 21, (H. F. Hudson).

Phymatidae

Phymata vicina Handl. Aweme, Man., 8, VII, 24, (N. Criddle).

Cercopidae

Lepyronia gibbosa Ball. Aweme, Man., 14, VIII, 24, (R. D. Bird).

Ephemeroptera

The following list prepared by G. S. Walley, under the direction of Dr. McDunnough, brings the known distribution of Canadian species up to date.

Ephemeridae

Ephoron (*Polymitarcys*) *leukon* Will. Kirk's Ferry, Que.
Hexagenia recurvata Morgan. Sand Lake, Ont.
Hexagenia atrocaudata McD. Lyn, Ont.
Hexagenia viridescens Wlk. Severn, Ont.
Hexagenia limbata var. *occulta* Walk. Wendigo Bay, Lake Nipigon, Ont. Former references to *limbata* Guer. should come under this heading.
Hexagenia affiliata McD. Sparrow Lake, Severn, Ottawa, Kingston, Algonquin Park, Ont.
Ephemera simulans Wlk. Pt. Pelee, Normandale, Ont.
Neoephemera bicolor McD. Laprairie, Que.
Potamanthus verticis Say. (*flaveola* Walsh). Niagara Falls, Bothwell, Ont.

Baetidae

Leptophlebia mollis Eaton. Kearney, Burk's Falls, Orillia, Ont.
Leptophlebia pallipes Hagen. Seton Lake, Lillooet, B.C.
**Leptophlebia temporalis* McD. Alta Lake, Mons, B.C.
Leptophlebia guttata McD. Burk's Falls, Jordan, Ont.
Leptophlebia moerens McD. St. Davids, Putnam, Bothwell, Ont.
Leptophlebia debilis Wlk. (*separata* Ulm.) Kearney, Ont.; Seton Lake, Lillooet, Agassiz, B.C.
**Leptophlebia bicornuta* McD. Bearberry Creek, near Sundre, Alta.; Shawnigan Lake, Vancouver Island, B.C.
Leptophlebia johnsoni McD. Kearney, Sand Lake, Ont.
**Leptophlebia ontario* McD. Jordan, Ball's Falls, Ont.
Leptophlebia rufivenosa Eaton. Goldstream, B.C.
**Leptophlebia invalida* McD. Departure Bay, B.C.
Blasturus cupidus Say. Sand Lake, Chatham, Bothwell, Ont.
Blasturus nebulosus Wlk. Kearney, Orillia, Bothwell, Ont.
Choroterpes basalis Banks. Lyn, Muskoka, Ont.
Habrophlebiodes americana Banks (*betteni* Need.) Centreville, Ont.
**Ephemerella flavilinea* McD. Waterton, B.C.
Ephemerella needhami McD. Laprairie, Lachine, Que.; Prescott, Ont.
Ephemerella tibialis McD. Slave Lake, Alta.
**Ephemerella inflata* McD. Wakefield, Que.
Ephemerella simplex McD. St. Annes, Lachine, Que.; Prescott, Niagara Glen, Normandale, Ont.
Ephemerella attenuata McD. Laprairie, Que.; Deadman's Creek, B.C.
Ephemerella funeralis McD. Kearney, Sand Lake, Ont.
**Ephemerella coxalis* McD. Dorval, Lachine, Coteau-du-lac, St. Annes, Beauharnois, Chateauguay, Que.; Kearney, Fisher's Glen, Ont.
Ephemerella inermis Eaton. Shuswap Lake, Penticton, B.C.
**Ephemerella semiflava* McD. Tillsonburg, Ont.
Ephemerella infrequens McD. Seton Lake, Lillooet, B.C.
Caenis hilaris Say. Ottawa, Ont.
Baetis bicaudatus Dodds. Seton Lake, Lillooet, B.C.
Baetis intermedius Dodds. Barkerville, Seton Lake, Lillooet, B.C.
Baetis parallela Banks. Medicine Hat. Alta.; Oliver, B.C.
Baetis moffatti Dodds. Barkerville, B.C.
Baetis vagans McD. Ottawa, Ont.
Baetis incertans McD. Orillia, Putnam, Ont.
Baetis brunneicolor McD. Ottawa, Fisher's Glen, Normandale, Walsh, Ont.
Baetis cingulatus McD. Orillia, Ont.
Baetis pallidula McD. Tillsonburg, Ont.
Baetis levitans McD. Orillia, Ont.
Baetis pluto McD. Lyn, Ont.
Baetis rusticans McD. Wakefield, Que.; Algonquin Park, Orillia, Ont.
Baetis parvus Dodds. Covey Hill, Hull, Que.; Orillia, Ball's Falls, Bothwell, Ont.; Alta Lake, Mons, Oliver, B.C.
**Baetis akataleptos* McD. Medicine Hat, Alta.
Baetis pygmaea Hag. Lachine, Que.; Orillia, Niagara Falls, Walsh, Put-in-Bay, Ont.
Baetis frondalis McD. Laprairie, Lachine, St. Annes, Hull, Que.; Algonquin, Brockville, Jordan, Ball's Falls, Pt. Bruce, Ont.
Baetis spinosus McD. Wakefield, Que.; Kearney, Burk's Falls, Walsh, Normandale, Pt. Bruce, Ont.; Darlingford, Aweme, Man.
**Baetis insignificans* McD. Seton Lake, Lillooet, B.C.
Baetis frivolus McD. Wakefield, Aylmer, Que.; Ottawa, Burk's Falls, Ont.
Heterocloeon curiosum McD. Laprairie, Que.; Niagara Falls, Ont.
Pseudocleon carolina Banks. Orillia, Ont.
Pseudocloeon virilis McD. Lachine, Vaudreuil, Que.; Niagara Falls, Putnam, Ont.
Pseudocloeon chlorops McD. Lachine, Que.
Pseudocloeon punctiventris McD. Laprairie, Lachine, Que.
Centroptilum fragile McD. Laprairie, Lachine, Que.; Cornwall, Ont.
Centroptilum ozburni McD. Lachine, Que.; Burk's Falls, Walsh, Normandale, Delhi, Ont.
Centroptilum bellum McD. Lachine, Que.; Jordan, Ball's Falls, Ont.
Centroptilum caliginosum McD. Lachine, Que.
**Centroptilum semirufum* McD. Kearney, Ont.
**Centroptilum album* McD. St. Annes, Que.; Orillia, Ont.
Cloeon implicatum McD. Waterton Lakes, Alta., Vernon, B.C.
**Cloeon minor* McD. Joe Lake, Algonquin Park, Ont.
Cloeon simplex McD. Laprairie, Lachine, Wakefield, Que.; Ottawa, Severn, Ont.
Cloeon insignificans McD. Ottawa, Ont.
Cloeon rubropicta McD. Laprairie, Lachine, Que.; Cornwall, Severn, Lake Muskoka, Niagara Falls, Walsh, Delhi, Ont.

Baetidae—*Continued.*

Callibaetis fluctuans Walsh. Fisher's Glen, Ont.
Callibaetis ferruginea Walsh. Putnam, Ont.
Callibaetis americanus Banks. Putnam, Ont.; Cypress Hills, Alta.
Isonychia bicolor Wlk. Niagara Falls, Ont.
Ameletus ludens Needh. Orillia, Ont.
Ameletus velox Dodds. Banff, Alta.; Barkerville, B.C.
Ameletus vernalis McD. Seton Lake, Lillooet, B.C.
Siphlonurus rapidus McD. Kearney, Orillia, Ont.
Siphlonurus bernice McD. Hopedale, Labrador; Kearney, Sand Lake, Burk's Falls, Ont.
Siphlonurus alternatus Say. Laprairie, Dorval, Que.; Burk's Falls, Ont.; Slave Lake, Alta.
Siphlonurus columbianus McD. Alta Lake, Mons, Agassiz, B.C.
**Siphlonurus securifer* McD. Algonquin Park, Ont.

Heptageniidae

Iron longimanus Eaton. Alta Lake, Mons, Seton Lake, Lillooet, B.C.
Iron pleuralis Banks. Scotch Lake, N.B.
Iron grandis McD. Seton Lake, Lillooet, B.C.
Iron suffusus McD. Vaudreuil, Laprairie, Dorval, Aylmer, Hull, Que.; Prescott, Ont.
Iron punctatus McD. Laprairie, Hull, Que.; Ottawa, Ont.
Iron deceptiva McD. Banff, Alta.; Barkerville, B.C.
Cinygma mimus Eaton. Alta Lake, Mons, B.C.
Cinygma ramaleyi Dodds. Mt. Cheam, Barkerville, B.C.
Cinygma hyalina McD. Seton Lake, Lillooet, Barkerville, B.C.
Cinygma bipunctata McD. Kearney, Ont.
Cinygma integrum Eaton. Alta Lake, Mons, B.C.
Anepeorus rusticus McD. Saskatoon, Sask.
Ecdyonurus frontalis Banks. Aylmer, Kirk's Ferry, Que.; Kearney, Severn, Lake Muskoka, Ont.
Ecdyonurus interpunctatus Say. (*flaveola* Pict.). Caradoc, Orillia, Niagara Falls, Queenston, Put in Bay, Normandale, Delhi, Pt. Bruce, Bothwell, Chatham, Pt. Pelee, Ont.
Ecdyonurus canadensis Wlk. Laprairie, Lachine, St. Annes, Chateauguay, Dorval, Que.; Prescott, Kingston, Orillia, Lake of Bays, Sand Lake, Kearney, Ont.
Ecdyonurus tripunctatus Banks. Anticosti Isd.; Laprairie, Chateauguay, Que.; Lyn, Orillia, Lake Muskoka, Kearney, Sand Lake, Jordan, Ball's Falls, Fisher's Glen, Normandale, Pt. Pelee, Ont.
Ecdyonurus vicarius Wlk. Macinquac, N.B.; Lachine, Que.; Kearney, Bothwell, Ont.
Ecdyonurus rubromaculatus Clem. Severn, Ont.
Ecdyonurus integer McD. Aylmer, Hull, Wakefield, Kirk's Ferry, Que.; Ottawa, Severn, Ont.
Ecdyonurus pulchella Walsh. Niagara Falls, Normandale, Tillsonburg, Ont.
**Ecdyonurus mediopunctatus* McD. Walsh, Victoria Harbour, Ont.
**Ecdyonurus bipunctatus* McD. Niagara Falls, Queenston, Cayuga, Normandale, Fisher's Glen, Bothwell, Pt. Pelee, Ont.
**Ecdyonurus ruber* McD. Laprairie, Lachine, Aylmer, Hull, Kirk's Ferry, Que.; Brockville, Ottawa, Burk's Falls, Ont.
Ecdyonurus placita Banks. Laprairie, Lachine, Dorval, Aylmer, Que.; Ottawa, Cornwall, Prescott, Brockville, Ont.
Ecdyonurus terminatus Walsh. Treesbank, Grand Beach, Man ; Waterton Lakes, Alta.
**Heptagenia perfida* McD. Jordan, Ball's Falls, Ont.
**Heptagenia horrida* McD. Jordan, St. Davids, Ont.
Heptagenia marginalis Banks. Laprairie, Kirk's Ferry, Que.
Heptagenia vitrea Wlk. Described from St. Martins Falls—Albany River, Ont., but not yet identified.
Heptagenia elegantula Eaton (*coxalis* Banks, *querula* McD.). Saskatoon, Sask.
Heptagenia solitaria McD. Nicola, Oliver, B.C.
Heptagenia pullus Clem. Lachine, Lanoraie, Que.; Kearney, Ont.
Heptagenia lucidipennis Clem. Laprairie, Lachine, Que.
Heptagenia inconspicua McD. Laprairie, Lachine, Que.; Walsh, Bothwell, Ont.
Heptagenia manifesta Eaton. Laprairie, Lachine, Kirk's Ferry, Que.
**Heptagenia walshi* McD. Walsh, Ont.
Heptagenia minerva McD. Lachine, Chateauguay, Que.; Burk's Falls, Bothwell, Ont.
**Heptagenia aphrodite* McD. Hull, Que.; Ottawa, Ont.
**Rhithrogena doddsi* McD. Waterton Lakes, Alta.
Rhithrogena jejuna Eaton (*fusca* Walk.). Saskatoon, Sask.,; Medicine Hat, Alta.; Deadman's Creek, Oliver, B.C.
Rhithrogena impersonata McD. Dorval, Laprairie, Lachine, Montreal, Que.

*Species marked thus are described in Can. Ent., Vol. LVIII, pp. 184-196, 296-303.

Orthoptera

Tryxalinae

Gomphocerus clavatus Thom. Cranbrook, B.C., (E. R. Buckell).

Oedipodinae

Trimerotropis vinculata Scud. Riding Mountain, Man., July, (E. Criddle).
Trimerotropis azurensis Brun. Drumheller, Alta., (Criddle and King).

Acrididae

Aeoloplus turnbulli Thom. Drumheller, Alta., (Criddle and King). Cypress and Minda, Alta., (Strickland).
Melanoplus flavidus Scud. Drumheller, Alta., (King).

Tettigoniidae

Conocephalus fasceatus De G. Gull Lake, Sask., (King).

INDEX

	Page
Aedes hirsuteron Theo.	9, 14
" *vexans* Mgn.	9, 16
Anopheles	16
Apanteles	22
Aphis brassicae	41
" *pseudobrassicae* Davis	41
Apple sucker	21
Armyworm	22
Balaninus caryae Horn	9
" *obtusus* Blanchard	9
" *proboscidus* Fab.	9
" *quercus* Horn	9
" *rectus* Say	9
Brown-tail moth	21
Cabbage aphis	41
" maggot	8
Case-making clothes moth	9
Cat flea	9
Cirphis unipuncta Haw.	22
Colorado potato beetle	8
Corethra cinctipes Coq.	17
Corn ear worm	42
Ctenocephalus felis Bouche	9
Currant fruit fly	38
Depressaria heracliana DeG.	8
Diamond-back moth	8
Epochra canadensis Loew	38
European corn borer	7, 21, 24, 28, 33, 35
" pine shoot moth	22
Exeristes roborator	22
Four-lined plant bug	8
Gracilaria syringella Fab.	8
Grasshoppers	8
Gypsy moth	21
Habrobracon brevicornis	22
Heliothis obsoleta	42
Hippodamia convergens	43
House flies	9
Hylemyia antiqua Meig.	8
" *brassicae* Bouche	8
Imported cabbage worm	8
Ladybird beetles	43
Leptinotarsa decemlineata Say	8
Lilac leaf miner	8
Lygus pratensis L.	8, 44
Malacosoma americana Fab.	8
" *disstria* Hb.	8
Maple leaf cutter	8
Melanoplus bivittatus Say	8
" *femur rubrum* DeG.	8
Mexican bean beetle	22
Microgaster	22
Mosquitoes	9, 12
Musca domestica	9
Mushroom mite	17
Oberea bimaculata Oliv.	8
Onion maggot	8
Paleacrita vernata Peck.	8
Paraclemensia acerifoliella Fitch	8
Parsnip webworm	8
Pieris rapae L.	8
Plutella maculipennis Curt.	8
Poecilocapsus lineatus Fab.	8
Pyrausta nubilalis Hubn.	7
Raspberry cane borer	8
Slugs	8
Spring cankerworm	8
Tarnished plant bug	8, 44
Tent caterpillars	8
Tinea pellionella L.	9
Tineola biselliella Hum.	9
Trichogramma minuta	34
Turnip aphid	41
Tyroglyphus farinae De Geer	17
" *lintneri* Osb.	17
Webbing clothes moth	9

Ontario Department of Agriculture

FIFTY-EIGHTH ANNUAL REPORT

OF THE

Entomological Society

of Ontario

1927

PRINTED BY ORDER OF

HON. J. S. MARTIN, Minister of Agriculture

UT INCEPIT FIDELIS SIC PERMANET

ONTARIO

TORONTO
Printed by the Printer to the King's Most Excellent Majesty
1928

CONTENTS

Page

OFFICERS FOR 1927-1928 4

FINANCIAL STATEMENT 4

Report of the Council 5

Report of the Curator and Librarian 6

Report of the Montreal Branch 6

Report of the British Columbia Branch 6

Report of Insects for the year—Division No. 1: C. B. HUTCHINGS 7

Division No. 6: H. F. HUDSON 8

Report on Insects of the Year 1927, in Nova Scotia: J. P. SPITTALL 9

Insects of the Season 1926 in Ontario: WILLIAM A. ROSS and L. CAESAR 15

Insects of the Season 1927 in Ontario: L. CAESAR and W. A. ROSS 19

Some Observations on Nicotine Dust: R. GLENDENNING 25

A Preliminary Report on Some of the Bud-moths and Leaf Rollers of Nova Scotia: F. C. GILLIATT 27

The Mexican Bean Beetle in Ontario: L. S. MCLAINE 39

Some Notes on the Life-History of the Mexican Bean Beetle in Ontario: H. F. HUDSON and A. A. WOOD 41

Latest Developments in the Control of Stored Product Pests with Calcium Cyanide: C. H. CURRAN 42

A Cheap and Effective Fly Spray: C. R. TWINN and F. A. HERMAN 43

Mosquito Control Activities in Western Canada: ERIC HEARLE 45

Field Crop Insect Conditions in Saskatchewan, 1922-27: KENNETH M. KING 50

The Corn Borer Act in Operation: L. CAESAR 51

Parasites of the European Corn Borer: D. W. JONES 55

The Spread and Degree of Infestation of the European Corn Borer in Canada, 1927: W. N. KEENAN 56

On the Occurrence of *Aphodius pardalis* Lec. as a Pest of Lawns in British Columbia: W. DOWNES 59

The Habits of the Onion Maggot Flies (*Hylemyia antiqua* Meigen): ALEX D. BAKER 61

The Canadian Insect Pest Survey: C. R. TWINN 67

Effect of Calcium Arsenate on Forest Trees: A. KELSALL and J. P. SPITTALL 69

The European Rose Sawfly in New Brunswick: R. P. GORHAM 70

The Golden-glow Borer (*Epiblema carolinana* Walsingham): R. W. THOMPSON 73

Forecasting Outbreaks of the Army Cutworm (*Chorizagrotis auxiliaris* Grote): H. L. SEAMANS 76

The Life of Professor William Lochhead: REV. FATHER LEOPOLD 86

The Entomological Record, 1927: NORMAN CRIDDLE 92

INDEX 105

Entomological Society of Ontario

OFFICERS FOR 1927-28

President—PROF. A. W. BAKER, B.S.A., O.A. College, Guelph.

Vice-President—PROF. J. D. DETWILER, University of West. Ontario, London, Ont.

Secretary-Treasurer—R. OZBURN, O. A. College, Guelph.

Curator and Librarian—MISS ROSE KING, O. A. College, Guelph.

Directors—Division No. 1, C. B. HUTCHINGS, Entomological Branch, Dept. of Agriculture, Ottawa; Division No. 2, C. E. GRANT, Orillia; Division No. 3, DR. NORMA FORD, Univ. of Toronto; Division No. 4, F. J. A. MORRIS, Peterborough; Division No. 5, DR. J. D. DETWILER, Western University, London; Division No. 6, H. F. HUDSON, Strathroy; Division No. 7, W. A. ROSS, Vineland Station.

Directors (ex-Presidents of the Society) REV. PROF. C. J. S. BETHUNE, Toronto; PROF. JOHN DEARNESS, London; JOHN D. EVANS, Trenton; PROF. E. M. WALKER, University of Toronto; ALBERT F. WINN, Westmount, Que.; PROF. LAWSON CAESAR, O. A. College, Guelph; ARTHUR GIBSON, Dominion Entomologist, Ottawa; MR. F. J. A. MORRIS, Peterborough; DR. J. H. SWAINE, Entomological Branch, Ottawa; REV. FATHER LEOPOLD, La Trappe, Que.

Editor of "The Canadian Entomologist"—DR. J. MCDUNNOUGH, Entomological Branch, Ottawa.

Delegate to the Royal Society of Canada—MR. A. GIBSON, Dominion Entomologist, Ottawa, Ont.

FINANCIAL STATEMENT

FOR THE YEAR ENDING OCTOBER 31ST, 1927

Receipts		*Expenditures*	
Cash on hand, 1926	$ 462.24	Printing	$1,410.00
Subscriptions	593.02	Annual Meeting	26.22
Dues	116.45	Expense	45.00
Advertisements	124.10	Cuts	38.96
Back Numbers	105.46	Salaries	290.00
Government Grant	1,000.00	Exchange	18.00
Bank Interest	11.47	Balance on hand	584.86
Exchange	.30		
	$2,413.04		$2,413.04
By cash on hand	$584.86		
To printing account payable	115 00		
Net balance	$469.86		

Respectfully submitted,

R. H. OZBURN,
Secretary-Treasurer.

Entomological Society of Ontario

REPORT OF THE COUNCIL

The Council of the Entomological Society of Ontario begs to present its report for the year 1926-27.

The sixty-third annual meeting of the Society was held at the Ontario Agricultural College, Guelph, on Tuesday and Wednesday, November 16th and 17th.

The morning and afternoon meetings were held in the Entomology Lecture Room, Biology Building. A smoker was held on Tuesday evening in the Faculty Clubroom in Memorial Hall.

The meetings were well attended by members of the Society from various provinces and by a number of visitors.

During the course of the meeting the following papers were presented:

Presidential Address—"Some Aspects of Economic Entomology in Quebec"—Rev. Father Leopold, Oka Agricultural Institute, La Trappe, Quebec.

"The Hazelnut Weevil, Balaninus obtusus"—C. B. Hutchings, Entomological Branch, Ottawa.

"Mosquito Control at Ottawa"—C. R. Twinn, Entomological Branch, Ottawa.

"Paradichlorobenzene as a Control for the Mushroom Mite"—L. Caesar, Ontario Agricutural College, Guelph.

"Recommendations and Directions for the Control of Insects under Indoor Conditions" —C. H. Curran, Entomological Branch, Ottawa.

"Review of the Canadian Species of the Dipterous Family Blepharoceridae"—G. S. Walley, Entomological Branch, Ottawa.

"The Activities of the Division of Foreign Pests Suppression in 1926"—L. S. McLaine, Entomological Branch, Ottawa.

"Notes on the Life History of the Army Worm, Cirphus unipuncta"—H. F. Hudson, Entomological Branch, Strathroy, Ontario.

"Parasites of White Grubs in Southern Quebec; a Progress Report"—C. E. Petch and G. H. Hammond, Entomological Branch, Hemmingford, Quebec.

"The Spread and Degree of Infestation of the European Corn Borer in 1926"—W. N. Keenan, Entomological Branch, Ottawa.

"The Occurrence of the European Corn Borer in Ontario in Plants other than Corn"—James Marshall, Ontario Agricultural College, Guelph.

"Mortality of European Corn Borer Larvae in 1926"—James Marshall, Ontario Agricultural College, Guelph.

"The European Corn Borer; the Outlook in Ontario"—L. Caesar, Ontario Agricultural College, Guelph.

"The Oriental Peach Moth Situation in Ontario"—W. A. Ross, T. Armstrong and R. W. Sheppard, Entomological Branch, Vineland Station, Ontario.

"Biology of the Currant Fruit-fly, Epochra canadensis, Loew. in Manitoba"—A. V. Mitchener, Manitoba Agricultural College, Winnipeg.

"Recent Work on the Codling Moth in Ontario"—J. A. Hall, Entomological Branch, Vineland Station, Ontario.

"The Determination of Arsenical Residues on Foliage"—F. A. Herman, Central Experimental Farm, Ottawa, and A. Kelsall, Entomological Branch, Ottawa.

"Miscellaneous Notes on the Blackberry Leaf Miner"—W. G. Garlick, Entomological Branch, Vineland Station, Ontario.

"An Outbreak of the Turnip Aphid, Aphis pseudobrassicae, Davis"—L. Caesar, Ontario Agricultural College, Guelph.

"Raspberry Aphids"—W. G. Garlick, Entomological Branch, Vineland Station, Ontario.

"How Oil Sprays Control the Pear Psylla"—W. A. Ross, Entomological Branch, Vineland Station, Ontario.

"Insects of the Season in Ontario"—L. Caesar, Ontario Agricultural College, Guelph, and W. A. Ross, Entomological Branch, Vineland Station, Ontario.

"Some Notes on the Oviposition Habits of Lygus pratensis—With a List of Host Plants"—R. H. Painter, Entomological Branch, Ottawa.

The Canadian Entomologist, the official organ of the Society, completed its fifty-eighth volume in December last. The volume contained 318 pages illustrated by three full page plates and twenty-six text figures. The contributors to these pages numbered forty-six and included writers in British Columbia, Alberta, Manitoba, Ontario, Quebec, Egypt and thirteen of the United States of America.

REPORT OF THE CURATOR AND LIBRARIAN

The Society's collections have been examined from time to time, and the necessary steps taken to prevent injury from museum pests. At the present time they are in good condition.

Numerous additions have been made to the library. It is expected that our accommodation will be considerably increased in the near future and the library will be then put in shape to be more readily available to members.

REPORT OF THE MONTREAL BRANCH

The fifty-fourth annnal meeting of this Branch was held on May 14, 1927, in the Lyman Entomological Room, McGill University, Montreal.

Eight meetings were held during the season in the Lyman Entomological Room and residences of members, with an average attendance of eight.

The following papers were read during the year:

"Insects Which Occur in Enormous Numbers"	A. F. Winn
"Strav Notes on the Birds, Orchids, Ferns and Butterflies of Mount Royal"	H. Mousley
"Notes on a Tachinid (Dipterous) Parasite of the Walking-stick Insect (Diapheromera femorata, Say)"	A. F. Winn
"Notes on Collecting at Lake Manitou"	Geo. A. Moore
"Local Wasps"	J. W. Buckle
"Inhibiting the Process of Metamorphosis in the Confused Flour Beetle (Trilobium confusum)"	Dr. J. K. Breitenbecker
"Insect Attractions"	A. F. Winn
"Earwigs (Dermaptera)"	A. F. Winn
"Surface Water Bugs"	Geo. A. Moore
"Conditions of Insect Life in British Columbia"	W. Downes
"Syrphus Flies"	G. Chagnon
"Assassin Bugs (Reduviidae)"	G. A. Moore

The following were elected officers for the year:—President, Geo. A. Moore; Vice-President, G. H. Hall; Secretary-Treasurer, J. W. Buckle; Council, A. F. Winn, G. Chagnon, A. C. Sheppard and G. H. Fisk.

REPORT OF THE BRITISH COLUMBIA BRANCH

The twenty-sixth annual meeting was held in the Hotel Vancouver, Vancouver, B.C., on February 26, 1927.

The following papers were read:

Presidential Address	J. W. Winson
"Some Insect Recently Intercepted by Quarantine"	W. H. Lyne
"Notes on Insects Hibernating in Dry Trees"	A. A. Dennys
"Recent Grasshopper Outbreaks in B.C."	P. N. Vroom
"Life History of Melittobia chalybii"	E. R. Buckell
"Records of Hymenoptera from B.C."	O. Whittaker

"The Status of the Narcissus Bulb Fly in B.C.".................G. J. Spencer
"Further Notes on the European Earwig"............................J. Stanley
"Notes on the Life History of the Cockroach".......................H. H. Ross
"Nicotine Dusts, Their Preparation and Uses......................R. Glendenning

The election of officers for the ensuing year resulted as follows:—Honorary President, F. Kermode; President, J. W. Winson; Vice-President (Coast), G. J. Spencer; Vice-President (Interior), E. R. Buckell; Advisory Board, the officers and Messrs. Downes, Lyne, Marmont, Venables, and Whittaker; Honorary Secretary-Treasurer, R. Glendenning. Agassiz, B.C.; Honorary Auditor, J. W. Eastham.

One new member was elected, and the financial statement showed a credit balance of $120.67.

REPORT OF INSECTS FOR THE YEAR 1927

Division No. 1, Ottawa District—C. B. Hutchings

The following more important insects were reported during 1927.

Field Crop and Garden Insects

European corn borer, *Pyrausta nubilalis* Hbn. A further spread of the corn borer has occurred this season. The degree of infestation in the previously infested districts has noticeably increased, although it is still light. Outbreaks were found this year as far north as Gracefield in Hull County; in Buckingham Township in Papineau County, and in the Townships of Onslow, Clarendon, Bristol, Calumet, Leitchfield, Mansfield and Oldfield in Pontiac County.

Carrot rust fly, *Psila rosae* Fab., did considerable damage and was the source of many complaints. A number of isolated outbreaks were recorded.

Spinach leaf miner, *Pegomyia hyoscyami* Panzer, attacked spinach and beets severely in many of the gardens, rendering the former unfit for consumption and stunting the growth of the latter.

Colorado potato beetle, *Leptinotarsa decemlineata* Say, was generally numerous in all potato patches.

Potato aphis, *Illinoia solanifolii* Ash. This pest was particularly severe throughout the district. Growers at Bowesville, Ont., suffered heavily; the crops, it is estimated, in some cases being reduced 30 per cent.

Imported cabbage worm, *Pieris rapae* L., was again reported in large numbers in the neighborhood of Billings Bridge, near Ottawa. The losses, however, were less severe than in 1926.

Cabbage maggot, *Hylemyia brassicae* Bouché, was present and caused considerable damage, specially in some of the larger gardens where control methods were not carried out.

Raspberry cane borer, *Oberea bimaculata* Oliv., which is usually severe in the numerous raspberry patches about Ottawa was noticeable for its absence this year, no complaints of any serious damage being recorded.

Black army cutworm, *Agrotis fennica* Tausch. A severe outbreak of this pest occurred at Bowesville, Ont., near Ottawa in June, the clover fields in that area being special objects of attack. It is interesting to record that these insects were later controlled by a parasitic fungus.

Tarnished plant bug, *Lygus pratensis* L., was numerous on garden plants during the latter part of the season, the fall generation being abundant.

Aphids were an outstanding pest and exceptionally abundant on all vegetation throughout the entire season, especially on fruit trees. Apple orchards were very severely attacked and marked damage was done to fruit and foliage. The cool, moist summer was likely responsible for their excess in numbers.

Spittle insects, *Cercopidae,* were unusually abundant on garden plants and grasses during June.

Slugs appeared in countless numbers in all gardens throughout the entire district and proved one of the primary pests of the year. Complaints were numerous and showed that a great variety of plants were attacked and widespread injury occurred especially to tomatoes and cabbage. The cool wet season favored their development.

Shade Tree Insects

Maple leaf cutter, *Paraclemensia acerifoliella* Fitch, was exceptionally abundant in many of the maple groves in the surrounding districts of Ottawa, one large sugar bush off the Prescott highway being very severely attacked.

Lilac leaf miner, *Gracilaria syringella* Fab. This pest was more general in its range and much more severe in its attack than in any previous year recorded. The second brood ruined practially every bush in Ottawa.

Eastern tent caterpillar, *Malacosoma americana* Fab., was abundant on apple, chokecherry and thorn. Little damage was recorded, likely due to the presence of parasites and a fungus which killed off the larvae in large numbers.

Le Conte's sawfly, *Neodiprion lecontei* Fitch. A number of young pines in neighboring districts suffered complete defoliation from this caterpillar and many valuable trees were killed or permanently disfigured.

Miscellaneous Insects

Owing to frequent, abundant rains, mosquitoes of the rain pool species, *Aedes vexans* Mgn., were prevalent in the Ottawa district, particularly outside of the area treated by the local mosquito control committee. The floodwater mosquito, *Aedes hirsuteron* Theo., abundant last season, was practically negligible due to low spring levels of the Ottawa River and to community control operations.

Houseflies, *Musca domestica* L., were less abundant than in 1926.

Division No 6—H. F. Hudson

The season has been rather cool, and somewhat dry, with the result that insect activity has not been particularly marked. The principal insect injuries of the year are noted below under their several headings:

Fruit Insects

Forest tent caterpillar, *Malacosoma disstria* Hb. These caterpillars were in outbreak form, and many orchards in Middlesex and Lambton Counties were defoliated. Larvae and pupae were heavily parasitised.

White-marked tussock moth, *Hemerocampa leucostigma* S. and A. Four acres of two-year-old apple stock in a local nursery were completely defoliated by this insect. No parasites were obtained from reared material.

Pear slug, *Eriocampoides limacina* Retz. Very abundant and injurious to pear and cherry trees.

Aphids, *Aphis pomi* De G., and *Myzus cerasi* Fab. Both species were very destructive, especially the apple aphid.

Field Crop Insects

Yellow-headed cutworm, *Septis arctica* Bdv. This cutworm was not as injurious as in former years. Several regional fields, suffered slight injury, those treated with poisoned bran gave almost perfect control.

European corn borer, *Pyrausta nubilalis* Hbn. A general increase throughout Middlesex County. Early corn was severely injured. As many as four larvae could be taken from single cobs of early sweet corn.

Hessian fly, *Phytophaga destructor* Say. A very light infestation was noted in two fields in Middlesex County.

Burdock borer, *Papaipema cataphracta* Grt. Present in several regional fields, boring into the stalks of potatoes.

White grubs, *Phyllophaga spp.* Injury to the potato crop by these insects was reported from Kent and Middlesex Counties.

Potato beetle, *Leptinotarsa decemlineata* Say. There was no increase of the pest over the past year.

Garden Insects

Stalk borers, *Papaipema cataphracta* Grt., and *P. nitela* Guen. Freely reported as injurious to tomatoes and rhubarb, as well as to many flowering plants.

Onion maggot, *Hylemyia antiqua* Meig. There was a slight increase in numbers and injury over the past year.

Cabbage worm, *Pieris rapae* L. Injury much lighter than usual.

Shade Tree Insects

Fall canker worm, *Alsophila pometaria* Harr. Very abundant in woodlots, many young maples defoliated.

REPORT ON INSECTS OF THE YEAR 1927, IN NOVA SCOTIA

J. P. Spittall, Dominion Entomological Laboratory,
Annapolis Royal, N.S.

Orchard Insects

Aphids—Nearly all species of vegetation were heavily infested with aphids.

Green Apple Aphid (*Aphis pomi* deG.). Apple twigs, covered with eggs, sent in from various places during the winter warned us of an impending outbreak of this pest. Strange to say, they were not particularly numerous until early July, when a period of wet, warm weather produced a tender luxuriant growth of shoots and suckers. Even in some of the best cared-for orchards they increased so rapidly that they got entirely beyond control, and individual growers at different places in the valley claim to have lost thousands of dollars by their work. The yellowish red larva of the predator, *Leucopis griseola* Fall., destroyed large numbers and although this predator became quite numerous by July 28, climatic conditions were apparently too much in favor of the aphids for it to have any appreciable effect. Another predator, a mirid, species not

identified, was also fairly numerous. The first nymphs of the green apple aphis were found on apple buds, April 23, which we believe is rather early for this province. While the green apple aphid did not appear to be generally numerous in orchards until late in the season, it was very plentiful in nurseries by May 12.

Apple Bud or Oat Aphid (*Aphis avenae* Fab.). This early spring visitor of the apple was present throughout the orchard area, but the writer has never observed any damage being caused by it.

Black Cherry Aphid (*Myzus cerasi* Fab.). Fairly numerous.

Woolly Apple Aphid (*Eriosoma lanigera* Hausm.). Present throughout the Annapolis valley, but apparently produced no appreciable damage.

APPLE LEAF TRUMPET MINER (*Tischeria malifoliella* Clem.)—Fairly prevalent in orchards outside the sprayed area in the west of the Annapolis valley.

APPLE MAGGOT (*Rhagoletis pomonella* Walsh)—The usual outbreaks occurred at the west end of the Annapolis valley, and the flies were fairly plentiful in one or two orchards at Windsor. Also reported in Nictaux, Annapolis County. At Acaciaville the early fruit in several orchards was 100 per cent. infested with maggots and most of the fruit was allowed to drop to the ground as worthless. In cages where the writer had placed apples the previous summer, the first flies emerged July 9, the earliest ever recorded in Nova Scotia, and were observed in orchards in Bear River July 13. Newly hatched larvae were found in Gravensteins as early as July 25, and dropped fruit with exit holes were found August 8. These emergence holes may have been made some days previously, so that it is possible that the maggots may go into the ground by the beginning of August.

APPLE RED BUG (*Lygidea mendax* Reut.)—The only place observed where this was at all numerous was in one orchard at Wilmot. As this species seems to frequent mostly the suckers of apple trees, the owner removed all the suckers and apparently the red bugs at the same time, for after a search of several hours the writer was unable to find a sufficient number there to experiment on, although they had been numerous previous to the removal of these growths. The red bug was also found in the Berwick and Starr's Point districts.

APPLE SEED CHALCID (*Syntomaspis druparum* Boh.)—A severe infestation was found at Windsor; also present in Smith's Cove, Digby County, and Gaspereau, Kings County.

BROWN TAIL MOTH (*Nygmia phaeorrhoea* Donovan)—This insect seems to be approaching the point of extinction in Nova Scotia. The number of nests found last winter was 19, against 95 in 1926, and 154 in 1925. There has been a gradual decline in the infestation of the browntail since the winter of 1913-14 when nearly 25,000 nests were collected. The nests found last winter were all in the Wolfville area and none at all have been found for several years in the district where originally they were so numerous.

BUDMOTH—In view of the epidemic of eye-spotted budmoth (*Spilonota ocellana* D. and S.) during this past two or three seasons, in our inspection of fruit each fall we have apparently being ascribing to that species some blemishes on the apples for which it was not guilty. While it was probably no worse than last year in the most heavily infested areas of Kings County, this year it was more generally widespread, and individual orchards in Annapolis County also had over 50 per cent. of the fruit marred. Two additional species (first reported from Nova Scotia by F. C. Gilliatt) have been identified this year, namely, *Pandemis limitata* Rob. and *Cacoecia*

persicana Fitch. Each of the above three species appears to make a more or less characteristic injury, yet at the same time a large percentage of the blemishes caused by each one resembles so much the work of the other two that we found it a difficult matter to segregate with more than a moderate degree of accuracy the work of the three species. Both *P. limitata* Rob. and *C. persicana* Fitch were present in our experimental orchards at Woodville, Port Williams, Berwick, Starr's Point, King County, and, while not generally numerous, are doubtless present throughout the fruit belt.

GREEN BUDWORM (*Argyroploce variegana* Hbn.)—For the first time we have to record a definite local outbreak of this hitherto lightly regarded insect. This occurred at Greenwich, Kings County. The foliage in one orchard looked as bad as that in some of the worst orchards infested with the eye-spotted budmoth.

CIGAR CASE BEARER (*Haploptilia fletcherella* Fern.)—Found at Middleton, N.S., and in orchards on Prince Edward Island. Quite numerous in one orchard near Middleton.

CODLING MOTH (*Carpocapsa pomonella* L.)—The status of the codling moth is not believed to be appreciably changed from 1926. Up to last year we were of the opinion that it had been slowly increasing. It is not a pest of economic importance in the fruit growing areas.

EUROPEAN APPLE SUCKER (*Psyllia mali* Schmid)—During last winter the eggs of the apple sucker were found to be as numerous as ever in the Wolfville district, many of the fruit spurs and twigs having a yellowish tint, so profusely were they sprinkled. The first nymphs were seen May 5. In the early part of June the writer received many calls to investigate injury to foliage in the east end of Annapolis and west end of Kings Counties. On investigating, it was found that a new area, namely: from Middleton to Kingston, was suffering from an epidemic condition of apple sucker and that most of the foliage injury reported was due to Bordeaux spray or dust having been used in orchards infested with this pest. The apple sucker survey this year revealed that this insect has now spread to Prince Edward Island, but it was not found beyond the boundaries of Westmorland and Albert Counties in New Brunswick. No survey was made at the west end of the Annapolis valley, but the writer found eggs at Roundhill, Annapolis County.

EUROPEAN RED MITE (*Paratetranychus pilosus* C. and F.)—This mite has been increasing for several years until now it must be recognized as one of the major apple orchard enemies. It is quite general in Kings County, and caused serious injury to some orchards. Points of severe outbreaks are Sheffield Mills, Berwick, Woodville and the Blomidon area, Kings County.

FALL CANKER WORM (*Alsophila pometaria* Harr.)—In 1925 the writer suggested that this insect was again on the increase, and it certainly has committed serious depredations in orchards the past two seasons. Even in many orchards fairly well looked after, enough canker worms survived control measures to devour not only much of the foliage, but also later in the season to gnaw the fruit. The writer has never before seen as much fruit eaten as this summer. In some orchards not only was the skin of the apple eaten, but in many instances the greater part of the fruit was consumed. That a severe outbreak was imminent was heralded by the discovery of large numbers of egg masses during the month of January. The first larvae were seen May 23.

GRAY-BANDED LEAF ROLLER (*Eulia mariana* Fern.)—This pest is common in some orchards in the Berwick and Woodville districts. While no definite outbreaks were found elsewhere, fruit was injured by this leaf

roller at different points throughout the Annapolis valley. Judging by the results of one of our experiments the numbers flying were on the wane by June 9.

GREEN APPLE BUG—(*Lygus communis* Knight)—This is still one of our major pests though somewhat overshadowed this year by the greater amount of injury caused by budmoth and aphids. It is believed that many of the early hatched green apple bug nymphs were destroyed by unfavorable climatic conditions this spring. In one orchard where the severely punctured foliage indicated the presence of this insect, practically none was to be found. A later inspection of the same orchard revealed the presence of many recently hatched nymphs with here and there a large one about one instar older. As an example of how numerous these creatures may become, after a treatment of nicotine dust the writer counted an average of 52 dead nymphs per square foot, indicating that about 16,000 green apple bugs per tree had been brought down. The eggs were still hatching up to June 9.

GREEN FRUIT WORM (*Graptolitha bethunei* G. and R.)—The eggs of the green fruit worm were found as early as April 23 on apple twigs. While this insect is believed to be present throughout the Annapolis valley, we have not found any pronounced outbreaks for some years.

LACE WING FLY (*Chrysopa spp.*)—Aphis lions were very numerous and in many orchards undoubtedly prevented the rosy aphids ruining the apple crop.

LADY BIRD BEETLES (*Coccinellidae*)—The larvae of these predators were quite numerous among rosy aphis colonies and in many orchards were undoubtedly a factor in the prevention of much injury.

LEAF HOPPERS—Both rose and apple leaf hoppers, *Empoa rosae* L. and *Empoasca unicolor* LeB., were numerous throughout the fruit belt, nymphs being observed as early as May 20 in a nursery at Upper Clements, Annapolis County. *E. rosae* was especially numerous at Berwick, Kings County, and by late summer severely blistered the foliage of some orchards.

LEAF SEWER (*Allononyma vicarialis* Zell.)—While this may not be a new arrival in Nova Scotia, this is the first summer that we have observed so much injury from it. Even with the work of the first generation, orchards at Smith's Cove, Digby County, looked as though a fire had run through them. By the time the second generation had finished its work, early fall, the greater part of the foliage of orchards from Digby to Moschelle, Annapolis County, had been skeletonized and assumed the characteristic light reddish brown hue.

MARCH FLY OR SAP SUCKER (*Bibio nervosus* Lw.)—This insect alarmed many of our farmers in May as they feared they were being subjected to an onslaught by a new pest. It was present throughout the valley in immense numbers but, as far as the writer could judge, no harm was done and, in fact, the nature of its mouth parts would preclude any such likelihood.

OBLIQUE-BANDED LEAF ROLLER (*Cacoecia rosaceana* Harr.) — The larvae were first seen out of their hibernacula April 23. While this insect has never developed in such epidemic proportions as *Spilonota ocellana,* it can be found generally in many districts of the Annapolis valley. At Berwick the larvae were quite heavily parasitized and it is to be hoped that a considerable reduction will be recorded in 1928.

ORCHARD TENT CATERPILLAR (*Malacosoma americana* Fab.)—The orchard tent caterpillar has not been particularly numerous for some years. In March egg masses were found to be fairly plentiful just east of Wolf-

ville, but generally the nests did not appear to be in much greater abundance than in 1926. On May 23 numerous nests were seen in an area near Middleton.

OYSTER SHELL SCALE (*Lepidosaphes ulmi* L.)—No appreciable change from last year; if anything, less numerous.

PEAR LEAF BLISTER MITE (*Eriophyes pyri* Pagnst.)—The blisters on pear foliage caused by this pest were common. There was a great deal more of this injury on apple than the writer has ever seen before.

PEAR PSYLLA (*Psyllia pyricola* Forst)—Numerous in isolated orchards, the worst infestation having been seen at Centerlea, Annapolis County, where a pear orchard was defoliated.

PISTOL CASE BEARER (*Haploptilia malivorella* Riley)—Found near Middleton. Not a pest of economic importance.

RIBBED COCOON MAKER OF APPLE (*Bucculatrix pomifoliella* Clem.)—Probably 30 per cent. of the apple trees in the Lequille area are infested with this insect.

SERPENTINE LEAF MINER (*Nepticula pomivorella* Pack.)—This insect is and has been quite numerous at Lequille, Annapolis County, for some years. Twigs bearing the pupal cases were received from Wolfville, Kings County. This insect is increasing in the west end of the Annapolis valley.

SYRPHIDS (*Syrphidae*)—The larvae of several species of syrphus flies were numerous and had it not been for them the amount of injury caused by the rosy aphis would have been much more serious.

SMALL FRUIT INSECTS

COTTONY MAPLE SCALE (*Pulvinaria vitis* L.)—The bushes in the black currant patch at the Experimental Farm, Kentville, were covered with this scale. A heavy fall of leaves occurred early in the season.

CURRANT FRUIT FLY (*Epochra canadensis* Loew.)—A red currant plantation on the Experimental Farm, Kentville, has had its yield reduced considerably for several years by this fruit fly. Repeated applications of nicotine dust apparently reduced the infestation as the yields were much larger this season. Gooseberries alongside the currants were also dropping off prematurely due to a larva in them. As the larva did not resemble the maggot in the currants a quantity of the fruit was placed in a cage in the hope of obtaining adults next year.

IMPORTED CURRANT WORM (*Pteronidea ribesii* Scop.)—Not so numerous at Annapolis Royal as in 1926. The larvae were heavily parasitized last year.

STRAWBERRY WEEVIL (*Anthonomus signatus* Say.)—While the weevil is still present in plantations at Berwick, it does not appear to be so serious a pest as two or three years ago.

GARDEN INSECTS

APHID (*Aphis rumicis* L.)—This aphid was a general pest on dahlias.

CARROT RUST FLY (*Psila rosae* Fab.)—Carrot patches at Annapolis Royal were infested with carrot rust fly larvae, but only to a small extent.

COMMON EEL WORM—Gardens in Halifax were severely infested with nematodes, probably *Heterodera radicicola* Greef.

DIAMOND BACK MOTH (*Plutella maculipennis* Curtis)—While these larvae were numerous on cabbage at Annapolis Royal, the amount of injury caused was unimportant as it was the lower leaves principally which were attacked.

FOUR LINED LEAF BUG (*Poecilocapsus lineatus* Fab.)—This mirid was numerous at Berwick, Kings County, during July and August. Dahlias, marigolds and pigweed showed the characteristic spots on the foliage where they had been punctured.

SLUGS (*Limax spp.*)—Much more numerous than in 1926, probably due to the wet summer. Gardeners had a great deal of trouble with them. They were plentiful until well on towards the end of November which we believe is rather late for them to be about in this province.

FIELD CROP INSECTS

COLORADO POTATO BEETLE (*Leptinotarsa decemlineata* Say.)—About as numerous as in 1926. A rather unusual feature was the damage done to young potato plants by over-wintering adults. In one field at Upper Clements, Annapolis County, the old beetles in the early part of the season gnawed off the young sprouts almost before the latter had time to get through the soil crust.

CORN LEAF APHID (*Aphis maidis* Fitch)—Moderate infestations seen at Weymouth, Digby County; Wilmot, Annapolis County; and at Berwick, Kings County.

CORN EAR WORM (*Heliothis obsoleta* Fab.)—Reported from Nictaux, Annapolis County. Not a pest of economic importance in Nova Scotia this year.

FLEA BEETLE (*Epitrix cucumeris* Harr.)—Reported from widely separated localities. By June 10 potato foliage at the Experimental Farm, Kentville, was riddled with holes and cabbage also in some places were attacked by flea beetles.

GRASSHOPPERS—The species *Dissosteira carolina* L. was abundant at Smith's Cove, Digby County. No reports of damage to crops were received in 1927.

JUNE BEETLES (*Phyllophaga* spp.)—No reports of outbreaks were received.

POTATO APHID (*Illinoia solanifolii* Ashm.)—No severe outbreaks reported or noticed.

POTATO STEM BORER (*Hydroecia micacea* Esp.)—This insect was reported as being present in Pictou County.

TARNISHED PLANT BUG (*Lygus pratensis* L.)—This omniverous feeder was everywhere and it would be difficult to form an estimate of the loss it causes. At Waterville, Kings County, 80 per cent. of the tops in a field of mangels were attacked, the injury being conspicuous by the bulbs on the leaves. The grower informed us that he had the same trouble each year.

ZEBRA CATERPILLAR (*Ceramica picta* Harr.)—Mangels at Waterville, Kings County, were attacked by the zebra caterpillars but not in sufficient numbers to cause appreciable loss.

FOREST AND SHADE TREE INSECTS

LARCH CASE BEARER (*Haploptilia laricella* Hb.)—Woods in Cumberland County, N.S., are still suffering from the ravages of the larch casebearer, the defoliation being so severe that it could be detected from a distance of half a mile. Two years ago this injury was general throughout the province.

LARCH SAW FLY (*Lygaeonematus erichsoni* Hart.)—Caused much injury—particuarly in areas between Windsor and Halifax.

FALL WEB-WORM (*Hyphantria cunea* Dru.)—Not numerous. Practically no difference from 1926.

TUSSOCK MOTHS—The first tussock moth larvae were found June 25. They have been comparatively scarce for several years in the Annapolis valley. However, egg masses were a little more numerous last winter in the eastern end of the Annapolis valley, and a severe outbreak occurred during the summer on Long Island near Grand Pre. Birches were defoliated and when the fruit in that vicinity was harvested a large percentage of apples was found to have been gnawed, and their grading seriously reduced. The writer did not have an opportunity to identify which species was doing the damage. Maple and other forest trees at Port Mouton and Yarmouth were almost defoliated by *Hemerocampa leucostigma* Sm. in August.

HOUSEHOLD INSECTS

BED BUG (*Cimex lectularius* L.)—A serious infestation was found in a hotel at Wolfville and the writer had no difficulty in finding numerous specimens of adults, nymphs and eggs. Practically all specimens were obtained by prying asunder parts of the wooden framework on which the spring mattresses rested.

BLACK CARPET BEETLE (*Attagenus piceus* Oliv.)—On January 31 this very objectionable household pest was found to have ruined several pairs of woollen socks stored in a trunk at Annapolis Royal. Exposure to as low a temperature as 7 degrees F. failed to kill individuals collected. Derris dust 100 per cent. had no effect on the larvae, and after napthalene had been shut in the trunk for months live larvae were still found.

Another beetle, presumably *Anthrenus scrophulariae* L. has for several years been a nuisance in residences at Annapolis Royal and Granville.

FALSE CRANE FLIES—A house at Annapolis was infested in November with one of the species *Rhyphus*.

HOUSEFLIES—Probably a little more numerous than in 1926. In the third week of November houses were invaded by flies in large numbers. By this date most householders had removed their window and door screens, but the fall being unusually warm, flies were apparently still numerous outside.

MOSQUITOS (*Culicidae*)—While these pests seemed bad enough last summer they were a veritable plague in 1927, and many householders were unable to sit out of doors at all in the evenings. Heavy rains throughout July kept renewing the supply of moisture in water holes and pools at a period when in an average season most of them would have dried up.

INSECTS OF THE SEASON 1926 IN ONTARIO

WILLIAM A. ROSS, DOMINION ENTOMOLOGICAL LABORATORY,
VINELAND STATION, AND
L. CAESAR, ONTARIO AGRICULTURAL COLLEGE, GUELPH

ORCHARD INSECTS

CODLING MOTH (*Cydia pomonella*)—There was an exceptional amount of "side-worm" injury in apple orchards in most parts of the province. Most of this injury was caused by first brood larvae, the second brood being unusually small.

SAN JOSE SCALE (*Aspidiotus perniciosus*)—Parasites and the unfavorable weather conditions of the past two years have reduced this insect to comparative insignificance. It is very scarce in the Niagara peninsula.

APPLE MAGGOT (*Rhagoletis pomonella*)—More than the usual number of complaints of apple maggot injury were received from many widely separated localities. Due to the cold, backward season, the adult flies were late in emerging, and consequently a spray, put on at the time usually recommended, was not so effective as it would have been, if it had been delayed ten to fourteen days. By way of record it should be mentioned that reports of injury were received from Galt, Waterdown, Barrie and Perth—localities from which the apple maggot has not been reported heretofore.

SPRING CANKERWORM (*Paleacrita vernata*) — Several neglected orchards in Halton, Haldimand, Norfolk, Brant and Huron were defoliated by this species.

APPLE LEAF HOPPERS (*Empoasca fabae* and *Typhlocyba rosae*)—The leaf hopper *E. fabae* was very abundant again on young apple trees in the Niagara district, and caused severe curling and some tip and marginal burning on the tender foliage. The rose leaf hopper was present in large numbers on apples in the Dixie locality.

GREEN APPLE BUG (*Lygus communis*)—A very serious outbreak of this troublesome pest in a large neglected orchard near Newcastle, has given rise to a considerable amount of apprehension among Newcastle fruit-growers, who naturally are afraid that the insect will spread into their orchards.

APPLE APHIDS (*Anuraphis roseus, Aphis pomi* and *Rhopalosiphum prunifoliae*)—The stem mothers of *A. roseus* and *A. pomi* were not at all abundant this year, and the stem mothers of *R. prunifoliae,* which usually are present in very large numbers on the bursting buds, were never more scarce in our experience.

The rosy aphis *A. roseus* caused no appreciable injury, but local outbreaks of the green aphis *A. pomi* occurred quite late in the season in different parts of the province.

APPLE LEAF-SEWER (*Ancylis nubeculana*)—A few orchards in Elgin County were severely attacked by the leaf-sewer this autumn.

RED-HUMPED APPLE CATERPILLAR (*Schizura concinna*)—This late feeding caterpillar was exceptionally numerous over a large part of western Ontario. In Grey and Huron Counties it was present on almost every other tree in many orchards.

YELLOW-NECKED CATERPILLAR (*Datana ministra*)—A half-acre orchard of quince trees in Essex County was nearly defoliated in mid-August by this species.

EASTERN TENT CATERPILLAR (*Malacosoma americana*)—There was an increase in the numbers of tent caterpillars in western Ontario—particularly in Middlesex and Muskoka. Fortunately so many of the insects were destroyed by disease or parasites that but few eggs were laid.

PEAR BLISTER MITE (*Eriophyes pyri*)—In the Georgian Bay district and also in many places east of Toronto, this mite has become fairly abundant in apple and pear orchards, which have not received a dormant spray of lime-sulphur for several years.

PEAR PSYLLA (*Psyllia pyri*) — The overwintering adults were very scarce this spring in most orchards, particularly in the Burlington district. Pear trees at Beamsville and Grimsby, which were not sprayed with oil, were quite badly infested with the insect in late summer, indicating that, if the vast majority of pear orchards, subject to psylla injury, had not been sprayed with oil, the insect would have caused about the usual amount of injury.

Pear Slug (*Eriocampoides limacina*)—In Elgin, Kent and Essex it was a common sight to see unsprayed cherry trees defoliated by this slug.

Plum Curculio (*Conotrachelus nenuphar*)—This insect was apparently more prevalent than usual in peach orchards in the Niagara district.

Oak and Hickory Plant Bugs (*Lygus quercalbae, L. omnivagus* and *L. caryae*)—These plant bugs again caused serious injury in several peach orchards in the Niagara district.

Peach Tree Borer (*Sanninoidea exitiosa*)—This insect was again injurious in southwestern Ontario orchards. It is of interest to note that the borer has always been of quite minor importance in the Niagara peninsula.

Cottony Peach Scale (*Pulvinaria amygdali*)—This scale insect, which caused so much injury in 1925 and 1926 along the Lake Ontario shore in New York State, is quite generally distributed throughout the Niagara peach belt, but, fortunately, is present in injurious numbers in but few peach and plum orchards.

Experiments, conducted in a badly infested peach orchard at Port Dalhousie, demonstrated that this scale can be controlled quite readily by spraying with a 4 per cent. lubricating oil emulsion spray.

Eulecanium Sp.—A species of *Eulecanium* was present in outbreak form in several plum orchards in the Niagara district. It was particularly abundant on Japanese varieties.

Tarnished Plant Bug (*Lygus pratensis*)—This insect was responsible again for a considerable amount of "stop-back" injury on peach nursery stock in the Niagara peninsula. St. John, Crawford and Elberta trees appear to be especially subject to injury.

Cotton Moth (*Alabama argillacea*)—In mid-September the cotton moth invaded southern Ontario in immense numbers. It was particuarly abundant in the Niagara peninsula, and by puncturing and feeding on fruit, chiefly peaches, it gave rise to wide spread alarm among fruit growers, who generally mistook it for the Oriental Peach Moth. Wild and alarming reports regarding the moth were published in the newspapers. One paper with a wide circulation in the Niagara peninsula informed its readers in a front page story that the peach moth, a scourge long dreaded by fruit growers, had finally struck the orchards and, practically overnight, had created untold havoc.

Last fall was the only time in our experience that the Cotton Moth caused noticeable injury in peach orchards.

Black Cherry Aphis (*Myzus cerasi*)—Stem mothers of this species were scarce this spring, and throughout the season the aphid was of minor importance.

Oriental Peach Moth (*Grapholitha molesta*)—This past season the Niagara peach belt and the peach growing sections in western Ontario were scouted and the following information regarding the distribution of the Oriental Peach Moth was secured:

A large orchard near St. Davids is the centre of what we are terming the St. Davids infestation. This orchard has been infested undoubtedly for several years, and from here the insect has in all probability spread by flight and by being carried by winds to Stamford on the south, the Niagara river (Queenston) on the east, and to the lake shore (Niagara-on-the-Lake) on the north. West of St. Davids there has been apparently little spread. What appear to be isolated infestations occur at the following points: In the vicinity of St. Catharines, where the moth appears to be confined to the territory within the triangle formed by St. Catharines, Port Dalhousie and Port Weller; at Peachland; at Vineland Station, where

at least three farms are infested; at Grimsby, where some eight orchards are now infested; at Bartonville; at Fonthill; and at Olinda and Albuna in Essex County. The St. Davids infestation appears to be by far the heaviest.

In the St. Davids orchard mentioned above, approximately 58 per cent. of the fruit was attacked by the peach moth and about 37 per cent. of this infested fruit showed no signs of external injury.

BLACKBERRY LEAF MINER (*Metallus rubi*)—Generally speaking, this insect caused but little damage in blackberry plantations.

RASPBERRY SAWFLY (*Monophadnoides rubi*)—This saw-fly was somewhat more abundant than usual in the Niagara district. Raspberry plantations at Stamford and Winona were almost completely defoliated by the larvae.

TRUCK CROP INSECTS

WIREWORMS—An unusually large number of letters were received from farmers, whose crops were being destroyed by wireworms. Some stated that, even though their land had been under cultivation for five or six years, the wireworms were still abundant.

CARROT RUST FLY (*Psila rosae*)—An otherwise excellent crop of about three acres of carrots near Dixie was so severely infested this fall with the rust fly maggot, that it was unmarketable. The owner stated that this was the first year he had had any trouble from this maggot. The insect was reported also from Arthur, Newmarket, Athens, Galt, Toronto, Prescott, Peterboro and Brampton. It is one of the insects which require careful study and the working out of satisfactory control measures.

ONION MAGGOT (*Hylemyia antiqua*)—There was about an average amount of damage done by the maggot throughout the province. Tests conducted during the past two years with lubricating oil emulsion gave good results, but this remedy has not yet been generally adopted.

IMPORTED CABBAGE WORM (*Pieris rapae*)—An unusually large number of the butterflies was to be seen in cabbage and turnip fields in Essex and Kent about mid-August and the foliage of these plants was much injured by the caterpillars.

TURNIP APHIS (*Aphis pseudobrassicae*)—For an account of the outbreak of this insect, see the 57th Annual Report of the Entomological Society of Ontario, page 41.

CABBAGE APHIS (*Aphis brassicae*)—There was a severe local outbreak of this aphid in Essex County, but by August 17th it was being brought under complete control by parasites and predaceous insects.

CORN EAR WORM (*Heliothis obsoleta*)—It is of interest to note that, though the corn ear worm was not at all abundant this year, specimens of it were received from as far north as Sudbury and Eauclaire.

CUTWORMS—There was about the usual number of complaints of cutworm injury this spring.

SEED-CORN MAGGOT (*Hylemyia cilicrura*)—At Ridgetown considerable damage was done to beans and at Welland to corn by the seed-corn maggot.

SLUGS, MILLIPEDES AND SOWBUGS—Many requests were received for information on how to combat these pests.

BILL BUGS (*Spenophorous sp.*)—In June, the agricultural representative for Brant County sent Professor A. W. Baker specimens of bill bugs found destroying young corn plants. Professor Baker traced the beetles down to the above genus, but, not being certain of the species, he sent specimens to an authority to be identified. Unfortunately they were lost in transit. Reports of bill bugs attacking corn or other plants in Ontario are very rarely received.

Miscellaneous

Red-Humped Oak Caterpillar (*Symmerista albifrons*)—This caterpillar, whose habits would entitle it to the name Red-humped Maple Caterpillar, was abundant in 1925 but still more abundant in 1926. In the former year it defoliated some maple woods in Bruce County and this year did the same in Huron. No reports were received from Bruce County, so we do not know whether the same woods were attacked there again. Even at Guelph the caterpillars were comparatively numerous.

Columbine Borer (*Papaipema purpurifascia*)—Several letters were received stating that columbines were attacked by a borer which proved to be *Papaipema purpurifascia*. One report of injury came from New Liskeard early in August.

Chrysanthemum Midge (*Diarthronomyia hypogaea*)—Specimens of chrysanthemums, severely infested with the midge, were received during October and November from Huntsville and Goderich.

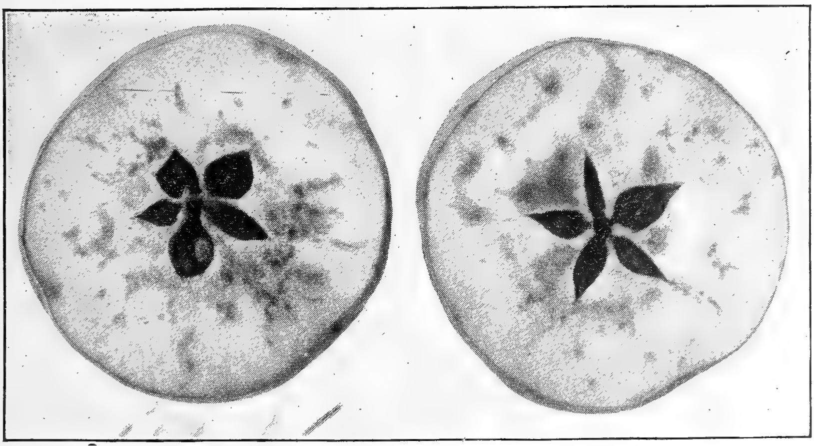
INSECTS OF THE SEASON 1927 IN ONTARIO

L. Caesar, Ontario Agricultural College, Guelph, Ontario, and W. A. Ross, Dominion Entomological Laboratory, Vineland Station

Orchard Insects

Codling Moth (*Carpocapsa pomonella* L.)—This pest caused somewhat less injury than usual.

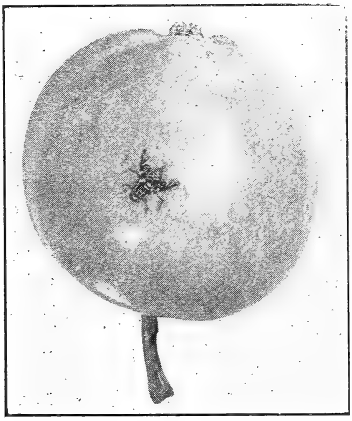
San José Scale (*Aspidiotus perniciosus* Comst.)—This insect is apparently even more scarce than it was last year. Very few trees in the Niagara district, even in unsprayed orchards, are infested.



Cross-section of apples showing the work of the Apple Maggot before the apples are ripe.

Apple Maggot (*Rhagoletis pomonella* Walsh)—Very much to our surprise there was a general outbreak of apple maggot in Norfolk County, and local outbreaks in the Niagara district, at Clarkson and in eastern Ontario. The situation in Norfolk, where about one-third of the orchards are badly infested, is particularly interesting, in view of the fact that heretofore in this county the apple maggot had never been of importance in

commercial orchards. The indications are that there must have been a considerable increase of the insect in 1926 and that the moist, cool weather of last July and August was exceptionally favorable for its multiplication. The apple maggot in the past has not been a serious pest in well-cared-for commercial orchards, and we have attributed this largely to the fact that in most seasons there is sufficient poison left on the trees from the calyx application (the last arsenical spray in most Ontario orchards) either to



A female adult of the Apple Maggot on the fruit, natural size. (Original.)

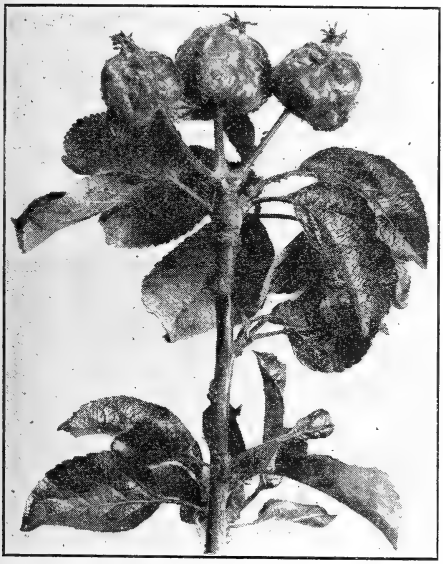
prevent the establishment of the maggot, or, where present, to keep it down to insignificant numbers. However, in a wet season like the past, there would be little if any arsenical residue on the trees at the time the flies emerged, hence in any orchard where the insect was present the calyx application would have no appreciable, if any, effect in controlling it.

GREEN APPLE APHIS (*Aphis pomi* De G.)—This past season will long be remembered by orchardists and entomologists as the year of the disastrous outbreak of green apple aphis. In intensity and duration the epidemic was by far the most serious we have ever experienced. All fruit-growing sections were affected, but the outbreak was much worse west of Bowmanville than in eastern Ontario.

The aphis was very abundant about the middle of June, and by the end of the month it was clustering in countless millions on the young growth and fruit. The outbreak continued throughout July and August and into early September, and caused immense losses. Thousands of apple trees were partially defoliated and seriously weakened, and a large percentage of the apple crop was ruined or degraded by the attack. Two factors were primarily responsible for the epidemic, viz: (1) the comparative scarcity of ladybird beetles, syrphid larvae and aphis lions, and (2) the cool, moist summer. Weather conditions, needless to say, played by far the more important role. Moderate temperatures provided the insect with optimum conditions of temperature for rapid multiplication, and the presence of a generous supply of moisture, by stimulating the production of succulent growth, furnished the insect with an abundance of the type of growth on which it thrives.

ROSY APPLE APHIS (*Anuraphis roseus* Baker)—In view of the superabundance of other species of plant lice, it is rather remarkable that this aphid was not more troublesome than usual.

Woolly Apple Aphis (*Eriosoma lanigera* Hausm.)—This species, evidently favored by the cool, moist summer, was much more numerous than in a normal season.



Green Aphis on Apple.

Aphids Clustering on Sweet Cherry.

Bud Moth (*Spilonota ocellana* D. and S.)—This species, while not present in outbreak form, was unusually abundant in some Ontario orchards.

Eastern Tent Caterpillar (*Malacosoma americana* Fab.) — This caterpillar was present in destructive numbers in almost all the counties from Lambton on the west, to Dundas on the east. The heaviest infestation we noted occurred between Toronto and Hamilton, especially along the Dundas highway, where many unsprayed orchards were almost completely defoliated.

Forest Tent Caterpillar (*Malacosoma disstria* Hbn.)—This pest was not much in evidence in any of the counties we visited except Lambton, where about a dozen apple orchards near Forest were completely or partially defoliated by it. The eastern tent caterpillar was also present but not in such large numbers.

Cigar Case Bearer (*Haploptilia fletcherella* Fern.)—This case-bearer was much in evidence in most unsprayed apple orchards. At Brighton it was present in sufficiently large numbers to cause the partial defoliation of a number of neglected orchards.

A Leaf Hopper on Apple (*Typhlocyba pomaria* McA.)—A leaf hopper was very abundant in many Ontario apple orchards, especially in Prince Edward, Northumberland, Durham, Peel, Wentworth, Lincoln and Norfolk Counties, and as a result of its activities, the foliage on badly infested trees was pallid and much of the fruit was specked with excreta. Collections of the hopper from Niagara, Burlington and Norfolk orchards were determined by Mr. W. J. Brown, Dominion Entomological Branch, as *Typhlocyba pomaria*, and the probabilities are that it was this same species which was prevalent east of Toronto. *T. pomaria* is very similar to the rose leaf

hopper *T. rosae* and has undoubtedy been confused frequently with this species.

APPLE RED BUG (*Lygidea mendax* Reut.)—This plant bug caused severe injury to the fruit in apple orchards at St. Catharines, Fenwick and Vinemount.

PEAR PSYLLA (*Psyllia pyricola* Forst.)—The worst epidemic of the pear psylla in our experience occurred this year. In the past this insect, generally speaking, has not been of importance in small orchards, except where sheltered by hedges or large trees, and it has not been of much consequence outside of the Niagara and Burlington districts. This year, however, practically all orchards along the south and west shores of Lake Ontario were badly infested, and the outbreak extended more or less throughout the province.

As in the case of the green apple aphis, moderate temperatures and an abundance of succulent growth undoubtedly were conducive to the rapid multiplication of the insect. Unfortunately many Niagara and Burlington growers failed to control the psylla, because, on account of the very wet and soft condition of the ground in late March and early April, they were unable to apply the dormant oil spray before egg-laying was under way. In orchards where spraying was properly done, one application of oil and one of nicotine sulphate gave good commercial control.

PEAR SLUG (*Eriocampoides limacina* Retz.)—Adults and eggs of this species were unusually abundant in a large nursery near St. Catharines. but severe injury was prevented by timely spraying. There has been no general outbreak of the slug since 1919.

PEAR BLISTER MITE (*Eriophyes pyri* Pgst.)—While there has been no general epidemic of blister mite during the past 14 or 15 years, local outbreaks have been noticed from time to time. This past season the mite was quite abundant on pears in a large nursery near St. Catharines.

CHERRY FRUIT FLY (*Rhagoletis cingulata* Loew.)—Like the closely related apple maggot, this insect was exceptionally abundant in cherry orchards in the Niagara district, which had not been regularly sprayed, and also in a number of orchards in other districts. At Guelph, from which place the maggot has not been reported heretofore, maggot-infested fruit was found in nearly every garden. No doubt the cool, moist June was remarkably favorable for the emergence of flies and for the laying of large numbers of eggs. Most of the injury was undoubtedly caused by *R. cingulata,* because *R. fausta* is extremely rare in the province.

BLACK CHERRY APHIS (*Myzus cerasi* Fab.)—Like the green apple aphis, this species was unusually abundant, and attacked not only sweet but also sour cherries.

PLUM CURCULIO (*Conotrachelus nenuphar* Hbst.)—This insect caused less than the average amount of injury.

PLUM APHIDS (*Hyalopterus arundinis* Fab., *Anuraphis cardui* L., and *Rhopalosiphum nymphaeae* L.)—Like many other plants, plum trees were badly infested with plant lice. Of the three species mentioned above, *H. arundinis,* as usual, was the most abundant and troublesome.

ORIENTAL PEACH MOTH (*Laspeyresia molesta* Busck.)—As anticipated, there was quite a extensive spread of this destructive pest in different parts of the Niagara district and in the vicinity of Olinda, Essex County. Mr. R. W. Sheppard of the Dominion Entomological Branch, also found it present in Harwich and Raleigh townships, Kent County. The insect, however, only occurred in severe outbreak form in Niagara township, Lincoln County, where it caused infestations running as high as 50 and 60 per cent.

Fruit growers, canners, fruit dealers and nurserymen, particularly in the Niagara peninsula, are all very much alarmed over the peach moth situation. They are very much afraid, that, judging by the past season's experience in Niagara township, if a remedy is not discovered, the moth will be responsible for enormous losses. There is good reason to believe that the moth did and will continue to affect very materially the demand for fresh and canned peaches; that it will cut down to a marked extent the planting of peach trees; and that it will be responsible for a serious depreciation in the value of fruit farms in the Niagara peninsula unless satisfactory means of reducing its ravages are found. At the present time it appears probable that there will be no sale for the fruit in a number of orchards in Niagara township next year, in view of the fact that several canners and fruit dealers have stated that they will not purchase peaches from that section next season.

EUROPEAN RED MITE (*Paratetranychus pilosus* C. and F.)—This pest became very abundant quite late in the season in the Burlington and Niagara fruit belt, and as usual was injurious particularly to European plums. Very satisfactory results in controlling it were secured from the use of home-made oil sprays.

GRAPE AND BUSH FRUIT INSECTS

ROSE CHAFER (*Macrodactylus subspinosus* Fab.)—Comparatively little damage was done by the rose chafer this season. The unusually severe outbreak of this pest, extending over several years has apparently now ended.

GRAPE LEAF HOPPERS (*Erythroneura spp.*)—These insects appeared in large numbers in some Niagara vineyards, and the probabilities are that many graperies will have to be sprayed for hopper control next year (1928). *E. comes* was the predominating species in the vicinity of Vineland.

GRAPE BERRY MOTH (*Polychrosis viteana* Clem.)—A local outbreak of this insect occurred at Niagara Falls and, in at least one vineyard completely ruined the crop.

GRAPE-VINE FLEA-BEETLE (*Haltica chalybea* Tll.)—This insect was again present in injurious numbers in several Niagara vineyards.

CURRANT APHIDS—Plant lice were exceptionally abundant on currant bushes, particularly in the Niagara district. *Myzus ribis* L. was the predominating species on red currants, and *Amphorophora lactucae* Kalt. on black varieties and gooseberries. The former species gives rise to pockets on the underside of the foliage, and the distorted portions of the leaves assume a conspicuous reddish color. The latter species twists and curls the terminal leaves, but causes no reddish discoloration.

RASPBERRY SAW-FLY (*Monophadnoides rubi* Harr.)—Local outbreaks of this insect at Winona and Vineland Station were prevented by timely spraying.

STRAWBERRY LEAF BEETLE (*Paria canella* Fab.)—Two raspberry plantations near Jordan were rather seriously injured by this species attacking the buds.

VEGETABLE INSECTS

CUTWORMS—There were about the usual number of complaints of cutworm injury. The most common species was taken to be the striped cutworm, *Euxoa tessellata* Harr. The caterpillars agreed closely with the description of this species, but, as no moths were reared, the identity of the cutworm was not definitely determined.

Cabbage Maggot (*Hylemyia brassicae* Bouche)—Fewer complaints of cabbage maggot injury were sent in than usual.

Onion Maggot (*Hylemyia antiqua* Mgn.)—There was about the average amount of onion maggot injury.

Carrot Rust Fly (*Psila rosae* Fab.)—The severe outbreak of last year was not repeated. At Dixie where hundreds of bushels of carrots were ruined in 1926 only a score or so were severely injured this year, though planted within a few yards of last year's plot. This is a good illustration of the way in which this insect seems to vary from year to year.

Turnip Aphis (*Rhopalosiphum pseudobrassicae* Davis)—It is interesting to note that this insect, though so remarkably abundant last year on turnips, caused no injury this year.

Wireworms—There have been many correspondents asking how to control these insects. The northern part of Wellington County has been very much troubled by them for several years and a method of rotation of crops which will bring about their destruction is not easy to put into practice.

White Grubs (*Phyllophaga spp.*)—Like wireworms these have been troublesome here and there but not more so than usual.

Seed Corn Maggot (*Hylemyia cilicrura* Rond.)—One would have expected a good deal of damage from this maggot owing to the cold backward spring but only one complaint—from St. Thomas—was received.

Spinach Leaf Miner (*Pegomyia hyoscyami* Panz.)—Numerous eggs were present on spinach and beet leaves in June but there was no serious amount of mining done by the larvae except in rare cases.

Slugs—Many persons, especially in the western part of the province, asked for remedies for slugs in their gardens which they reported were doing serious damage.

Corn Aphids (*Aphis maidis* Fitch)—Dark green aphids were very numerous in most corn fields during August and September. They fed on the new growth in August, and in September were chiefly in the sheltered area between the stem and the enveloping leaves.

European Corn Borer (*Pyrausta nubilalis* Hbn.)—This insect is discussed elsewhere in this Annual Report.

Miscellaneous

Hemlock Looper—In Muskoka in the Lake Joseph and several other localities a serious outbreak of a hemlock looper was noticed in 1926 and was continued in 1927. Already many trees have been killed as a result of the 1926 attack and the beauty of the summer resorts is in consequence much marred. The outbreak is evidently not over, for a correspondent says, at the end of September, the trunks of the hemlocks were almost covered with moths. Apparently the only way to combat this pest is by aeroplane dusting. The owners, several of whom are wealthy, would, we feel, be glad to assist in the expense. The species responsible has not been definitely determined but from the description of the larvae, and the time of pupation and emergence of the moths it is probably *Ellopia fiscellaria* Gn.

Spiny Oak Worm (*Anisota senatoria* S. and A.)—Near Sarnia this fall white oak woods were stripped almost bare by this insect. Red oaks were undamaged. The same thing happened in the same woods in 1926. This caterpillar has often been noticed by the senior writer to have defoliated white oaks here and there in the southwestern part of the province but he has never seen it do so much damage as recorded above.

MAPLE LEAF-MIDGE—At Walkerville, in August, most of the terminal soft leaves of maples were crumpled, thickened, stunted and largely destroyed by tiny white dipterous maggots about two millimetres long. These maggots were enclosed in the crumpled or thickened portions of the leaves. There is very little doubt that the insect responsible was *Rhabdophaga aceris*. This is the first time, however, that the writer has seen its injury in the province.

LILAC LEAF-MINER (*Gracilaria syringella* Fab.)—This comparatively new insect is becoming a great pest and threatens to ruin the lilacs of the province unless combated. At St. Catharines, privet was attacked, apparently by the same species. (In England, privet is given as one of the regular host plants.) The work of the miner was observed at, or reported from Guelph, Toronto, Mono Road, Dixie, St. Catharines, Niagara Falls, Meadowvale, Fort Erie, Hamilton, and in fact, appears to be widely distributed throughout the province.

POWDER-POST BEETLE (*Lyctus sp.*)—During the last three years specimens of the work of one or more of these beetles have been sent in from various parts of the province but especially from the southwestern portion. Beams, floors and joists of houses, barns and churches were attacked.

MUSHROOM MITE (*Tyroglyphus lintneri*)—In last year's report the senior writer gave a paper on the control of this mite by paradichlorobenzene. Another opportunity to test out this control was given through the presence of the mites in a large mushroom bed at Thornhill. Excellent results were again obtained here and considerable further information obtained on how to improve the method of treatment outlined in last year's paper. A brief account of the treatment has been included in the revised edition of the bulletin on "Mushrooms of Ontario," No. 303, Ontario Department of Agriculture.

SOME OBSERVATIONS ON NICOTINE DUST

R. GLENDENNING, AGASSIZ, B.C.

Three factors have been noted which govern the successful application of nicotine dust, these are: firstly, strength, that is, percentage of nicotine in the dust; secondly, condition of the atmosphere at the time of dusting; and, thirdly, length of time during which the insect is enveloped in the dust. In the experience at Agassiz which are quoted hereafter, hydrated lime, only, was used as a carrier for the nicotine.

Strength—It was found that the strength necessary to kill varied with the insect. For the cabbage flea beetle, *Phyllotreta albionica* Lec., a three per cent. dust, actual nicotine content, was required to obtain a ninety per cent. kill, while the hop aphis, *Phorodon humuli* Schr., was destroyed readily with a one per cent. dust.

A four per cent. dust was tried on cabbage flea beetles and gave practically one hundred per cent. mortality. This strength, representing a proportion of ten per cent. nicotine sulphate, was inclined to be too damp and to cake, and did not distribute readily from a hand duster. The cost was, also, rather high. It would appear from our work that, with hydrated lime as a carrier, a three per cent. dust is as high a percentage as is practical and economical.

The average mortality with varying strengths of nicotine dust on flea beetles ran in a fairly regular progression, the average for one per cent. dust being forty-four per cent., for two per cent. dust, sixty-eight per cent., and for three per cent. dust, ninety-one per cent.

Conditions of the Atmosphere at Time of Dusting—Three conditions are considered in this connection: air movement, temperature, and humidity.

The first, that is, air movement, is the most important with all types of dusting and especially with nicotine dust, as, even a moderate wind interferes with the application of any type of dust. In dusting for the hop aphis the slight air movements could be largely overcome by extra heavy applications, but this was found to increase the cost excessively. In dusting for the cabbage flea beetle, however, air movement seemed to be of less importance, as a number of our experiments were carried out with a slight breeze blowing. This species, however, seems peculiarly susceptible to nicotine fumes.

The second condition, temperature, is important only when using hand operated machines or power machines without agitators. It was found that a minimum shade temperature of 70 degrees F. was necessary for an effective kill when distributing nicotine dust from hand guns, rotary or bellows types of hand dusters, but in the case of power machines a one hundred per cent. mortality on hop aphis was obtained at a temperature of 50 degrees F. This was probably due to the fact that the agitators in the hopper of the machine raise the temperature of the dust to about 130 degrees F. so that the gas is liberated regardless of the temperature of the outside air.

The third condition, humidity, has been mentioned as affecting the properties of nicotine dust; but in our experiments and observations at Agassiz, it seemed to be of no practical importance. Our dusting was as effective on dry as on damp days, taking the temperature into consideration, and the addition of six per cent. moisture to the dusts produced no markedly different results.

Length of Exposure to the Fumes—This factor in the case of dusting for aphids seems to be the most important. It is governed, of course, to a great extent, by the previously mentioned condition, air movement, as it is impossible to get prolonged exposure to nicotine fumes in a wind.

We found when dusting for aphis in the hop yards at Agassiz that in a dead calm the fumes would hang over the rows for thirty seconds or more, and whenever this occurred a one hundred per cent. mortality was affected. With slight air currents the cloud of dust would drift off the vines in ten seconds or less and the resultant kill was reduced to sixty per cent. or less.

It was noted, however, in 1926, that if the vines were heavily coated with dust by discharging from one pipe only, a high percentage of mortality could be obtained even in a slight breeze. This was probably caused by the dense coating of lime deposited on the leaves which continued to liberate the gas for some time after deposition. The cost of this method of application, however, was excessive, both in the amount of material used and in the time taken to cover the ground.

Some Experiments with Nicotine Fumes—Some experiments were conducted in an endeavor to decide the actual length of exposure necessary to kill hop aphis with nicotine fumes. Glass vessels of about one-half gallon capacity, were charged with nicotine fumes by puffing in dust from a hand gun. Hop leaves infested with lice were then introduced for periods varying from five to forty seconds. Several tests were made for each period and the results showed that with five seconds exposure only about fifty per cent. of the lice were killed and these were always the younger individuals. Ten seconds exposure gave from fifty to eighty per cent. mortality in different experiments, and fifteen seconds exposure showed a

mortality of ninety-five per cent., while twenty, thirty and forty seconds immersion in the gas gave a one hundred per cent. kill.

These experiments were, of course, somewhat deficient, as we had no means of measuring the concentration of the gas in the vessels, except that we attempted to approximate the density of the cloud with that given by the power duster in the field. It would appear, however, both from the experiments as outlined above and from observation made in the field that exposure to the nicotine fumes for fifteen seconds at least is necessary to kill hop aphis.

In the case of the cabbage flea beetle and the hop flea beetle, an exposure of only three seconds or so is sufficient to cause death. The different results obtained from the experiments on flea beetles and aphids may be due to the varying rates of respiration. In this connection it is interesting to note that the flea beetles loose all power of movement and are apparently dead in fifteen seconds, whereas the hop aphis will often remain alive from twelve to twenty-four hours after dusting.

Costs—With an orchard power duster, refitted with a four-way union supplying four delivery pipes, each two inches in diameter, we were able to dust hops successfully at a cost per acre of $9.35 for material and $1.00 for labor, 200 pounds of dust being used. During the last four years, spraying costs for hops have run from $10.75 to $15.00 per acre for each application. The lower figure represents the use of an improved form of automatic delivery machine which was introduced this year.

Despite these favorable figures it is unlikely that dusting will ever supplant spraying in the hop yards of British Columbia owing to the limited time during which atmospheric conditions will permit efficient dusting. Night dusting is, I believe, often resorted to in hop gardens in England, but labor on the Pacific coast does not take kindly to this form of exercise.

Nicotine dust will, however, continue to be used in the hop yards especially in years of red spider outbreaks, as a combination dust of ground sulphur, hydrated lime and nicotine sulphate has been found most effective in destroying both spider and aphis at one operation. Nicotine dust has proved, however, the only suitable control for the cabbage flea beetle, and is being largely adopted in the Lower Fraser valley as both practical and economical.

A PRELIMINARY REPORT ON SOME OF THE BUD-MOTHS AND LEAF ROLLERS OF NOVA SCOTIA

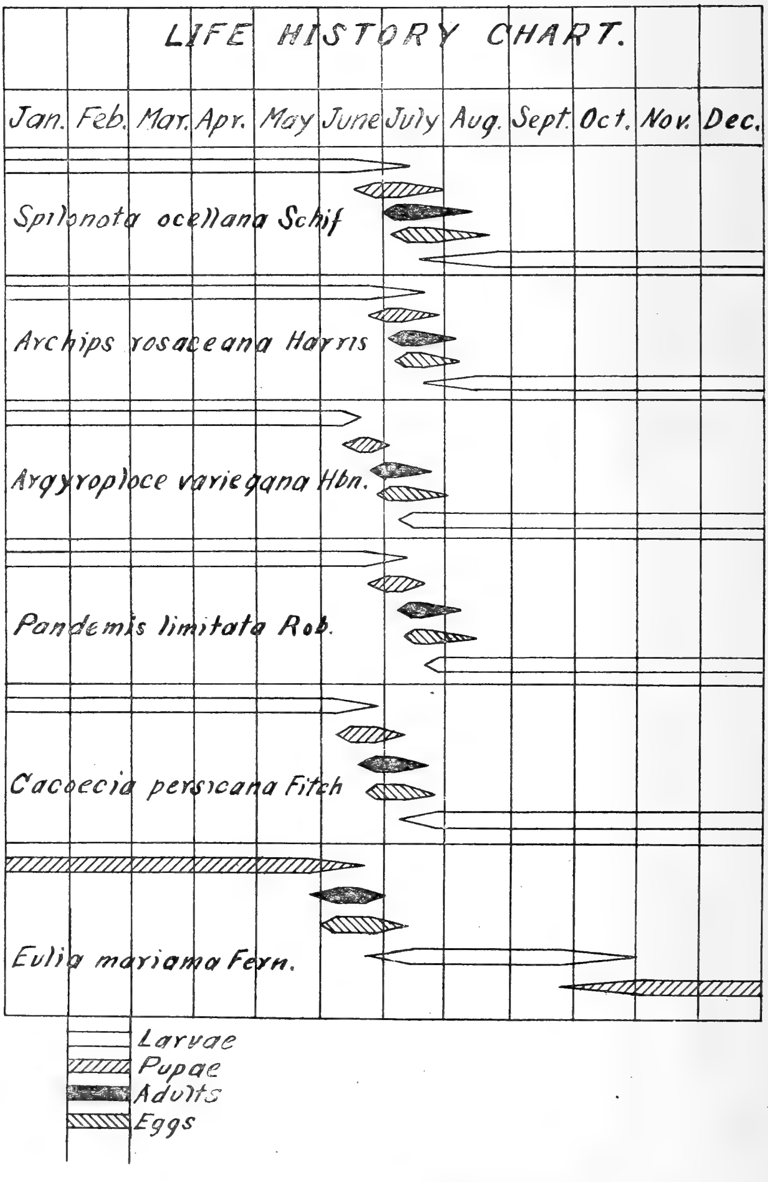
F. C. Gilliatt, Dominion Entomological Laboratory,
Annapolis Royal, N.S.

It is apparent that no entomologist has attempted to draw any well defined line between insects commonly called leaf-rollers and those termed bud-moths. Such would be rather a difficult task, as the group is a very large one and many species have habits which are characteristic of both. One would naturally assume that bud-moths, for at least a certain period, feed within or upon the buds; but some of these also, at other periods, have more of the leaf-roller habits. It is, therefore, difficult to question any writer who defines a certain species as a bud-moth while another may wish to call it a leaf-roller.

In the Annapolis Valley, the subject of bud-moths and leaf-rollers has engrossed the attention of the fruit growers particularly during the past

few years. The writer in 1926 started a detailed study of the life-history and habits, etc., of these orchard insects, and this paper I wish to be considered as an introductory one, leading up to a more complete and detailed report, which is in course of preparation.

When starting this study only the well known bud-moth came under observation. It was not long, however, before it became apparent that others were present which had not previously been reported and were prac-



In the above life history chart is indicated the number of broods and the comparative length of the various life stages of some bud-moths and leaf rollers of apple in Nova Scotia. Each stage has been drawn to represent the average for the past two years as near as it was possible to do in a chart of this size.

tically unknown to the growers, or even to individuals more familiar with insect life. Some of these were already in sufficient numbers to cause considerable damage. To combat the worst of these orchard insects, control measures are more or less established, for others, these are still in the experimental stage, and for the more recently discovered ones practically nothing has been done in this regard. The writer took no direct part in any control work, and such therefore, will not be discussed in this report.

Spilonota ocellana D. and S.

It is well known that under Nova Scotia conditions, this species winters as partly grown larvae in hibernacula upon the trees. These hibernacula are constructed of tightly woven whitish silk more or less covered on the outside with fine pellets of blackish frass. They are to be found under old bud scales, around buds, in the axils of small fruit spurs, and in various other obscure locations upon the smaller branches. When the larvae are numerous, they often construct hibernacula side by side or even on top of each other, thus forming colonies with each larva constructing and occupying its own individual cell.

When the buds begin to swell in the spring, the larvae emerge from their hibernacula. As a rule, the first to appear is during the last week in April. The period of emergence usually lasts for about three weeks, and when mature, pupation occurs in the bunched foliage upon the tree. Pupation begins during the middle of June, but reaches its maximum during the last week of June and the first week of July. The adults emerge after a pupal period of from fourteen to twenty days and in the average season, become numerous in the orchard by the end of the first week in July. Although the period of adult emergence is rather prolonged, the maximum occurs over a ten to twelve day period centering around July 10. After a pre-oviposition period of from two to five days, the eggs are deposited singly on both the upper and lower surface of the leaves, and at first are rather transparent in appearance, not unlike a tiny droplet of wax. The number of eggs deposited by each female is about 150. There is an incubation period of from ten to twelve days and the young larvae begin to make their appearance upon the leaves about the middle of July.

At the very end of August the larvae, when in the fourth instar, begin to desert the foliage and at once construct their hibernacula in such positions upon the tree as previously mentioned. By the end of September the major portion of the larvae are to be found within their winter quarters. There is only one brood of this insect in Nova Scotia.

Habits of Larvae in the Spring—The larvae, previous to emerging from their winter quarters, become restless, and thin out the hibernaculum until the inner lining is apparently consumed. This is followed by making a small circular exit sufficient to allow their escape. There is usually a delay of several days, after the exit is made, before they actually emerge to feed. The duration of this period of activity within the hibernacula, with full opportunity to escape, depends much upon the weather conditions prevailing at the time. This habit was later found to be an important factor in the application of control, making it possible for certain spray materials to be forced through the small opening, or to penetrate in some instances the thinned hibernacula and kill the larvae by contact before emerging.

The larvae first eat their way into the nearest buds and feed upon the tender portion within. As the blossom buds are the first to show green at this time they are always the most heavily infested. Although frequently blossom buds are entirely destroyed, this does not necessarily fol-

low, as the buds expand rapidly at this time, providing sufficient feeding surface. The larvae, therefore, feed more from one side of the bud, resulting in only a partial destruction of the blossom. The leaves and blossoms, however, instead of expanding normally, are held together with silk, thus presenting a bunched and unhealthy appearance. The skeletonized leaves in these bunches die and turn brown, and together with the dried blossom clusters, remain upon the tree for the greater part of the summer. At this time, particular note should be made of this dead bunched condition, following the feeding of *S. ocellana,* as it has special significance when studying the life history of other species which are discussed later in this paper.

Habits of the Adults—The adults, which are small grayish moths, generally may be found at rest upon the trees during the day. In the early evening they become very active, being on the wing in myriads through and over the trees.

Habits of the Larvae at Hatching Time—The larvae begin to feed, soon after hatching, upon the under surface of the leaves. In feeding they skeletonize the foliage and also spin a mat of tightly woven silk which spreads out flat over their feeding area, and affords protection beneath, also, wherever possible, they tie these leaves to the side of the fruit, feeding from both surfaces. At the very end of August they begin to desert the foliage and commence to construct their hibernacula. From 90 to 95 per cent. of the larvae hibernate during the month of September.

Bud and Leaf Injury—In light and moderate infestations the bud and leaf injury is ordinarily not very serious. However, with the degree of infestation now existing in the Annapolis Valley orchards, the effect upon the trees from this type of injury is becoming more apparent. In the spring, under some conditions, buds may be totally destroyed, this injury applying particularly to leaf buds. All infested buds are more or less injured and although there is no defoliation, the leaf area is much reduced, due to the skeletonizing of the foliage. Such feeding together with the webbed or bunched condition of the foliage interferes with normal development.

In the early fall the young larvae again skeletonize the foliage to a serious extent. It is not unusual to find orchards with a reduction of 25 to 80 per cent. of the total leaf area, from this source alone.

It is difficult to estimate the combined bud and leaf injury under such conditions, but the vitality of the tree must be impaired, and it is little wonder that such infested orchards frequently fail to set more than a moderate crop of fruit.

Fruit Injury—In 1927 the larvae were often observed feeding upon the surface of recently set fruit. This was frequently deep into the flesh, resulting in more or less deformity at picking time with russeted area over the eaten surface. There is a variation from year to year in the prevalence of this type of injury, due probably to seasonal variations. The injury of greatest concern is the scarring of the fruit, beginning as soon as the larvae hatch and continuing until they hibernate. Under the attached leaves, previously mentioned, the larvae consume small portions of the fruit. This at first, consists of not more than a few irregular punctures upon the surface. These are enlarged and added to until shallow excavations are spread over a considerable portion of the fruit.

Natural Control—There is ordinarily a winter mortality within the hibernacula of from 15 to 25 per cent. of the larvae. During the past two seasons some dipterous and hymenopterous parasites were recovered but the number was exceedingly small. An egg parasite identified as *Tricho-*

gramma minutum was of some significance during the season of 1927. It was found to be well established over the infested area, and in some orchards as high as 31.5 per cent. of the eggs were parasitized. If there should be a further increase of this egg parasite it would result in an important control factor. There were a few predators; spiders apparently being the most important. These various factors combined however, are as yet insufficient to prevent an increase of the insect.

Economic Importance—This species is the worst insect pest in the Annapolis Valley at the present time. The area, seriously infested, includes a large portion of the Valley and is apparently still spreading. The combined injuries resulting from this insect has rendered many fruit crops almost a complete loss.

Cacoecia rosaceana Harris

This species, perhaps better known as "The Oblique-banded Leaf-roller" is familiar to most entomologists, as it is more or less scattered over the American continent. It has a wide range of food plants, twenty-one having been listed, those of the rose family being the most important. It is recognized as an orchard insect and under some conditions may become a pest of some importance. Although scattered over the Annapolis Valley it is not so well-known to the fruit grower as *S. ocellana,* because it has not become a pest of the same economic importance.

Life-History—Like *S. ocellana,* the winter is passed as partly grown larvae, in typical hibernacula upon the trees. The location and construction of the hibernacula of these two insects is so similar that from outward appearances it is difficult to differentiate this one from the other. In the spring as the buds are beginning to swell the larvae emerge. This emergence, however, is usually a few days in advance, and not so prolonged as *S. ocellana.* The larvae mature during the latter part of June, pupating within the leaves which they have webbed together and to which the pupa are loosely attached. There is a pupal period of from twelve to sixteen days and the adults begin to appear in the orchard before or by the end of the first week in July. The period between emergence and the beginning of ovipositing, ranges from two to five days. The eggs are deposited in flat masses upon the upper surface of the leaves. The individual eggs overlap each other so that there is only one-third to one-half of the egg exposed. The number in each mass varies from less than one hundred to as many as three hundred and sixty-five. Each female usually lays more than one mass and the largest number of eggs deposited by a single female was found to be seven hundred and seventy. After an incubation period of from twelve to sixteen days, the larvae begin to emerge; this will be under outside conditions, about July 20. As the larvae pass the winter in the third instar there is only a brief feeding period, varying from fourteen to twenty days, before they begin to hibernate. This begins about August 8 and continues until the end of the month, when only a few stray larvae are to be found which have not deserted their feeding positions. Under Nova Scotia conditions this species has only one brood, but in latitudes farther south it is known to have two broods.

Habits of the Larvae—As soon as the larvae emerge from the hibernacula in the spring they bore into the buds, either at the tip where the green is beginning to show, or at the side through the bud scales. There is therefore, at this time a short period when they are well protected within the bud. After the buds have opened and the leaves are of some size the larvae roll up one leaf or draw several together in a loose bunch and upon the margins of these and the surrounding foliage the larvae feed.

There is, therefore, rather more unprotected surface feeding than is the case with *S. ocellana*. During the last instar they frequently wander from their feeding positions, other leaves being drawn together in a similar manner, within which they finally pupate.

Habits of the Larvae in the Fall—The larvae, as soon as they escape from the eggs, are very active and the majority crawl at once to the edge of the leaf, soon dropping, suspended by a silky thread. This silk is often spun to some length and affords an opportunity for the larvae to be caught up by other leaves upon the tree. This process is frequently repeated being persisted in until favorable positions are finally located. It is within the old webbed together leaves, blossom clusters, etc., which are still clinging on the trees as a result of the spring feeding of *S. ocellana,* that we find the larvae of *C. rosaceana* at this time. If such or similar material is not located they persist in spinning down from the foliage until they finally drop to the ground where the most of them perish. The conclusions arrived at in this regard is that *C. rosaceana* under orchard conditions is liable to increase with *S. ocellana* and is almost sure to decrease with it.

After the tiny larvae have located in this webbed together material, they further secure it to the living leaves with silk and then feed by skeletonizing the foliage. Wherever accessible this infested material is drawn in close contact with the fruit, the larvae feeding on both surfaces.

Bud and Leaf Injury—In the early spring there is very much the same bud injury as noted with *S. ocellana.* There is also a certain amount of leaf feeding and in some instances the terminal growth of the shoots may be checked as it is a common habit for them to feed upon these tender growing leaves. In the most severely infested orchards in Nova Scotia, no approach of defoliation has been noted. In the early fall the larvae consume so little and are feeding for so short a period that the damage to the foliage, at this time, is not appreciable.

Fruit Injury—The larvae have frequently been observed eating deep holes into the fruit soon after it has set. Much of the fruit thus injured is so weakened that it drops prematurely. On the fruit that remains, scars at picking time are similar to those caused by the early feeding of *S. ocellana,* only they are usually larger and deeper. There is ordinarily not enough of this type of injury to be serious.

Like *S. ocellana,* the injury of most economic importance is that caused by the larvae soon after hatching when they web the leaves in close contact and feed upon the surface. The resulting scars upon the fruit at picking time produced by these two insects are similar, in fact it is difficult in most instances to determine the difference between them. Relatively, this fruit injury caused by *C. rosaceana* is not so pronounced on account of the shorter feeding period previous to hibernating.

Natural Control—The habits of this insect are such that it is readily attacked by parasites. In orchards where not more than a few stray parasites were recovered from *S. ocellana,* the larvae of *C. rosaceana* were heavily parasitized. These included several species of both hymenopterous and dipterous parasites. The egg parasite *Trichogramma minutum* was also in evidence, in some instances every egg in the mass being occupied by this minute insect. There is also a small percentage of winter mortality within the hibernacula.

Economic Importance—As a serious orchard pest in Nova Scotia, at the present time, this species is not to be compared with *S. ocellana.* Although found over the entire fruit section there is only a small area in the Berwick district where any degree of injury is apparent. Should *S. ocellana,* however, continue to persist then there is also the possibility of *C.*

rosaceana increasing and eventually becoming an orchard pest of considerable economic importance.

Argyroploce variegana Hbn.

In the bulletin prepared by Sanders and Dustin in 1919 entitled "The Apple Bud-moths and Their Control in Nova Scotia," this species was mentioned as being found only in the vicinity of Kentville. It has, since that time, apparently increased and spread, as during the summer of 1927 it was found to be well scattered over the eastern half of Kings County; some orchards in the vicinity of Wolfville and Kentville being, moderately to rather severely, infested.

Life-History—Like *C. rosaceana* the insect passes the winter as third stage larvae in hibernacula upon the trees. The construction and position of these hibernacula are similar to those of the two previously described species.

In the spring the tiny larvae emerge even a little earlier than *C. rosaceana.* In 1927 the first larvae were noticed, attempting to enter a bud, on April 22. Although the buds had swollen but little on this date the larvae seemed quite capable of boring through the bud scales to the tender portion beneath. After the leaves have expanded they are drawn together in loose bunches, this occurs to a very large extent at the tender terminal growth. The larva rests within this leafy protection and when feeding consumes small portions of the margins of the surrounding foliage. It is mainly when the larvae first emerge that they attack the blossom buds, confining their feeding very largely to the leaves after they have expanded. Pupation takes place between the webbed together leaves upon the tree. This occurs about June 10 and the adults begin to appear in the orchards about June 25. There is a pupal period of fifteen to eighteen days. The period over which the adults emerge is comparatively short, in the average season the maximum occurs during the first days of July.

The adults resemble, rather closely, those of *S. ocellana,* and are frequently mistaken for them. This is due to the similarity of coloring in the adults of these two species. The *A. variegana* adults, however, are larger, and the gray or lighter portion on the fore-wing is at the apex instead of across the middle of the wing as in *S. ocellana.* When the adults have reached their maximum number in the orchard those of *S. ocellana* are just making their appearance. On account of this mistaken identity many fruit growers thinking that the latter insect emerges at an earlier date, might apply control measures prematurely.

Egg deposition occurs from three to five days after the adults emerge. The eggs are deposited singly upon the lower or under surface of the foliage, and resemble closely those of *S. ocellana.* There is an incubation period of from ten to twelve days. The larvae do not spin down but soon start feeding upon the lower surface of the leaf on which the egg was placed. A protective covering of silk is soon spun, under which the larva feeds. There is, on the average, only about fifteen days of larval feeding before hibernation begins for the winter. In 1926 and also in 1927 this hibernating habit was in evidence during the last days of July and by August 12 all had deserted the leaves and had entered their winter quarters. Like the two previous insects there is only one brood in Nova Scotia.

Larval Injury—The most noticable injury is the damage to the buds in the early spring, also leaf feeding during the early growing season. In the worst infested orchards the leaves were badly bunched and although by no means any defoliation, there was considerable reduction of leaf area, the trees presenting far from a normal appearance.

Due to the very brief feeding period at mid-summer and to their habit of hibernating so early when the fruit is still small there is not presented the same opportunity for fruit scarring so pronounced with other insects of this group. Some of the worst infested orchards were under observation during the summer of 1927 but only in a few instances were larvae noticed injuring the fruit.

Economic Importance—It is reasonable to conclude from data gathered during the past two seasons, that this insect under good orchard management is not liable to become a pest of major importance. The fruit injury under moderate infestation is very slight and it is doubtful if much would occur in severe outbreaks on account of the short feeding period and its early hibernating habits. However, the worst known infested orchards are those indifferently sprayed and the data available in this regard points to at least a fairly satisfactory control with arsenicals.

Pandemis limitata Rob.

When collecting *C. rosaceana* larvae in 1926 it was noticed that all were not typical, some being smaller, having a lighter colored head and pro-shield. These were separated and given a different serial number. The adults were later identified as *Pandemis limitata* Rob. The species therefore is not well known to Nova Scotia fruit growers, in fact few are aware of its presence and do not realize the possibility of it becoming another orchard pest.

The records available regarding this insect appear to be somewhat limited. W. T. M. Forbes in his memoir No. 68, "The Lepidoptera of New York and Neighboring States" mentions it as a general feeder especially on trees. S. W. Frost in "Journal of Economic Entomology," December, 1926, has it recorded from Pennsylvania as feeding on oak, beech, rose, hazel, sassafrass, as well as on apple. The writer found the larvae feeding on apple, no observations having been made for other possible food plants.

Life-History—The life-history and habits of this species under Nova Scotia conditions has been worked out in detail, and found to correspond very closely with *C. rosaceana*. The larvae pass the winter in hibernacula upon the tree and emerge in the spring to eat their way into the opening buds. This emergence is a little later than that of *C. rosaceana,* usually not occurring until toward the middle of May. The larvae feed upon the buds in a similar manner, rolling the leaves and feeding upon the margins, webbing these into loose bunches for protection. When mature, which occurs the latter part of June, they pupate webbed up in the leaves which they have drawn together. After a pupal period of eleven to sixteen days the adults emerge; the first appearance in orchards is about July 10. The eggs are deposited in from three to five days in masses upon the upper surface of the leaves, and overlap each other in a manner similar to *C. rosaceana*. There is an incubation period varying from ten to twelve days, hatching beginning about July 25.

The larval habits, at hatching time, are similar to *C. rosaceana,* as previous to any feeding they soon drop from the leaf and remain suspended until other leaves are reached, in this manner they are distributed to all parts of the tree. This insect is also dependent to a very large extent upon *S. ocellana,* as they continue to drop from the leaves until the old webbed together foliage of the latter insect is finally occupied.

The larvae use these as a protection, for the brief period, previous to hibernating. From observations to date it appears fairly conclusive that *P. limitata* is so dependent upon *S. ocellana* in this respect that it is not likely to become an orchard pest of much importance, except in such pre-

viously infested orchards. These bunches, when in contact with the fruit, afford an opportunity for the larvae to feed upon the surface resulting in more or less injury to the fruit.

Toward the middle of August the larvae begin to leave these protective positions on the tree and seek out suitable places to hibernate for the winter. The position and construction of these hibernacula are similar to those which have been previously mentioned. There is only one brood in Nova Scotia.

Larval Injury—There has not been an opportunity to study this species under epidemic conditions. However, the observations so far indicate that the worst feature of this insect is the larval habit of scarring the fruit. The injury begins soon after the larvae have hatched continuing until they hibernate. This scarring usually consists of a single or a series of small circular holes on the surface. The attached leaf or leaves being so loosely tied to the fruit, these after being deserted by the larvae are soon blown or washed off by the rain. Upon exposure, there soon appears a purplish or reddish circular area about the injury, which markings are characteristic of this insect.

The bud and leaf feeding habits being so similar to *C. rosaceana* the injury in this respect is also of much the same nature.

Economic Importance—The presence of this insect has been noted in many localities during the past two seasons, and in a few instances there has been considerable fruit injury. It is to be found chiefly in those districts where *S. ocellana* is the most numerous, and where the latter insect has been a pest for some time it appears to be on the increase. As long as *S. ocellana* continues to persist in Nova Scotia orchards there is danger of *P. limitata* becoming an orchard pest of considerable economic importance.

Cacoecia persicana Fitch

This species has been recorded by W. T. M. Forbes in his memoir No. 68 as occuring from Maine to Manitoba, feeding on various plants, but no plant in particular being mentioned. It was first observed by the writer in Nova Scotia during the summer of 1926 feeding upon apple, but since a few larvae have been noted feeding on sorrel and apparently developing normally. As far as known this insect has not been previously reported as an orchard pest.

Life-History—This species passes the winter as fifth stage larvae, in the fallen leaves upon the ground. During the first part of May, or when the buds are opening, the larvae emerge from the leaves and ascend the trees. This statement is made without having actually observed the larvae crawling up the trunk, but in view of the fact that they are known to winter on the ground and are to be found in the early spring feeding upon the buds; there appears at this time no other deduction. Further observations, however, are to be made in this connection in 1928. The larvae attack the first green buds they chance upon in their ascent. These may be on the water sprouts growing about the base, or they may crawl to the top of the tree or to the farthest lateral branches. At first the larvae spin some rather close fitting silk about the opening bud and under this feed as the leaves expand. They are, therefore, outside feeders and do not bore into or enter the bud. Later a leaf or several leaves are loosely rolled together, and thus protected they consume small portions of the surrounding foliage.

When mature, which occurs early in June, the larvae descend the tree by crawling down the trunk. In this descent a number pupate in the loose rough bark, while the remainder descend to the ground, where they roll up

an old fallen leaf near the trunk and pupate within. After a pupal period of about two weeks the adults emerge. There is a preoviposition period of two to four days, the egg then being deposited upon the upper surface of the leaves and probably also on the smooth bark of the larger limbs. The eggs are laid in masses and closely resemble those of the previous insect. They hatch in twelve to fifteen days and the young larvae appear upon the trees during the first week in July.

After hatching the larvae spin down from the leaf and distribute to various parts of the tree. There is the same larval habit, of feeding more or less concealed, as noted with other insects of this group. Soon after emerging they are to be found within the calyx of the apple; in the old dried bunched leaves still clinging to the tree as result of *S. ocellana* infestations, also in various other secluded positions. When the third instar is reached they begin to leave these various feeding positions and for the remainder of the season show an aptitude for more or less fruit feeding—and have the habit of concealing themselves in various ways in close contact with the fruit.

The webbed together foliage, within which the larvae are concealed, finally becomes detached from the tree through winds, rain, etc., and thus reach the ground, this occurs during September and continues well into October. There is only one brood under Nova Scotia conditions.

Larval Injury—Evidently the calyx is used merely as a place of concealment, as actual feeding within was noted only in a few instances. They do, however, partly emerge and eat small circular holes immediately around the outside. From these punctures the juice frequently appears in small droplets, which soon dries, leaving a creamy colored deposit around the calyx. This in some instances is quite unsightly, but frequently will not be noticed unless closely examined.

The most pronounced injury is the habit which the larvae have of eating from the surface of the fruit. This feeding causes scars and side injury and although usually not deep into the flesh, the fruit thus marked is rendered quite unfit for market.

Economic Importance—This species is well established in the central part of the Annapolis Valley and already causing considerable fruit injury. During 1927 a number of growers who treated their orchards thoroughly for *S. ocellana* in the adult stage with satisfactory results found, at picking time, that *C. persicana* had apparently increased and caused more side injury than the former insect. In these orchards it has without doubt been present for a longer period than generally realized and previous to the present season probably some of *C. persicana* injury has been attributed to *S. ocellana*. This injury in some instances amounted to as much as 7 to 8 per cent. of the fruit.

The sod or semi-sod mulch system is becoming somewhat popular in certain districts and each year finds a few more growers adopting this method of orchard treatment. It can be readily understood that this system will foster a certain group of insects, some of which are those that winter, rolled up in the fallen leaves upon the ground. With clean cultivation there is little danger of this becoming a pest of much importance for the hibernating material is buried in the process of plowing, harrowing, etc. It is in the sod mulch orchards that the insect is mainly found and where it is most likely to increase in the future.

Eulia mariana Fern. and *E. quadrifasciana* Fern.

There are several species of this genus which have been reported from various states of the American Union as important apple pests. *Eulia*

mariana is recorded by S. W. Frost from Pennsylvania. It has also been found in Maine, Massachusetts, and New York States feeding on oak and blueberry. It first became prominent in Nova Scotia during the fall of 1925, when it was found feeding on both the foliage and fruit of the apple. Since 1925 various other food plants have been noted in Nova Scotia including our most common deciduous forest trees as well as several weeds. It is well established as an orchard pest around Berwick and has been observed in many scattered parts of the Valley indicating that it is well distributed over the fruit growing district. Owing to the general gray ground color of the adult, the common name "the gray-banded leaf roller" has been given to this insect.

Life-History—The winter is passed in the pupal stage enclosed within the fallen leaves upon the ground. The emergence of the adults in the spring depends somewhat upon weather conditions and may occur during the latter part of May or be delayed until the first week of June. During 1927 the first to appear was when the Gravenstein variety reached the advanced pink stage. Ovipositing usually begins on the third day after emerging, the eggs being deposited on the upper surface of the foliage, and also on the smooth bark of the larger limbs. They are laid in masses, containing from fifty to one hundred and forty eggs, and in appearance are similar to those of the previously described species which oviposit in this manner. After an incubation period of about twenty days, hatching begins which occurs during the latter part of June, continuing into July. The larval period is very prolonged lasting seventy-five days or more, and it is not until the latter part of September that they begin to pupate. A few pupate enclosed within rolled up leaves upon the tree, but by far the larger number, first, drop to the ground and pupate within the fallen leaves. There is only one complete brood in Nova Scotia.

Habits of the Adults—The adults are inactive during the day, being at rest in the grass beneath the trees or upon the trunk, often concealed under the rough bark. The number observed by passing through an infested orchard is by no means an accurate indication of the number present, as they are so concealed and inactive in these various places. They are more active in the evening, and are often noticed flying among the branches and between the trees, but at this time they are not readily observed in any numbers even in those orchards where a considerable degree of infestation is known to exist.

Habits of the Larvae—Upon hatching, there is the same larval habit of dropping from the foliage and swinging by a thread as noted with other species. The larvae however, soon cease their activity and locate singly on the under surface of the leaves usually along the mid-rib. They first feed by skeletonizing the foliage, and there is also spun a tough covering of silk which spreads out flat over their feeding area. Due to contraction of this silk, the leaves become rolled toward the under surface. When about half grown they begin to desert the leaves and crawl short distances locating on the upper surface of a single leaf, or several leaves may be gathered together in a loose bunch. As the larvae always feed more or less concealed, it is at this time they tie the foliage to the side of the fruit, invariably resulting in very pronounced injury.

Economic Importance—The gray-banded leaf roller has become prominent in certain districts since its discovery in 1925, due to the pronounced fruit injury. The larvae prefer to feed concealed between overlapping leaves, but wherever accessible they tie the leaves with silk to the fruit, resulting in their feeding upon the surface. This feeding is usually not deep, but may be spread over one-third to one-half of the surface. This

occurs when the fruit is so near maturity that no protective covering is formed, frequently resulting in early decay. The insect has the habit of localizing in certain areas in the orchard. In 1925 as high as 25 per cent. of the fruit was scarred in some of these infested areas. In 1926 and 1927 there was considerable variation in its attack, some orchards showing more injury, while in others there was less.

The insect is encouraged under the sod mulch system, it being quite conclusive that under clean cultivation it will never come to any prominence as an orchard pest. It is also fairly conclusive that arsenicals as ordinarily applied are ineffective as a means of control, this at least in part is due to the larval habit of feeding concealed. In any event, the larvae appear so late upon the foliage that it is usually unsafe to apply arsenicals due to the arsenical residue remaining upon the fruit. *E. mariana* is an important insect pest and will demand new treatments for its control.

Eulia quadrifasciana Fern.

This species has been reported from New York State as an apple pest. In Nova Scotia a larva was found at Annapolis on June 14 feeding on apple foliage. This pupated on July 12 and the adult emerged on July 30 which was later identified by Dr. J. McDunnough as *E. quadrifasciana* Fern. This was the only record obtained, and as far as the writer is aware, this insect has not been previously reported from Nova Scotia.

Allononyma vicarialis Zell.

This species is reported by W. T. M. Forbes as occurring from Nova Scotia to New Hampshire and west to British Columbia, feeding on birch.

During 1926 and 1927, in the district from Annapolis west to Digby, a distance of about twenty miles, the larvae so skeletonized the apple foliage that the green portion in many instances was completely consumed. This was so general that whole orchards presented a brown appearance for long distances. The writer has been unable to find any mention of this insect elsewhere as a pest on apple.

Only a few brief life-history notes were made during 1927. There is evidently two broods in Nova Scotia, the adults of the first brood appearing in July, and those of the second brood late in September extending into October. The larvae roll a single leaf toward the upper surface, and within they feed by skeletonizing until only the veins remain. When mature they move to the under surface, spin a white, very dense, tough web and concealed between this and the leaf transform to pupa. It is the second brood larvae that cause the most injury. It is not definitely known how the winter is passed but probably the insect hibernates in the adult stage.

In the above infested area spraying is not generally practised, but in the few treated orchards the insect is not found in any numbers. The contrast between sprayed and unsprayed orchards in this regard is very pronounced, indicating that it is controlled with the regular spring spraying.

Tortrix afflictana Wlk.

A few larvae of this species were collected in various parts of the Annapolis Valley both in 1926 and 1927. They were found feeding on apple foliage and in one instance in September of 1927, feeding upon the fruit. Judging by the few observed feeding upon the foliage, they appear to have the typical leaf roller habits.

There is probably only one brood in Nova Scotia, the larvae maturing late in the fall and hibernating enclosed within the fallen leaves. The larvae evidently pupate very early in the spring, as those collected in October and examined late in December were found still in the larval stage, but on examining early in April were found to have pupated. The adults emerged on June 7th and 9th.

This species is reported by Forbes as occurring from Newfoundland to Texas and California, caterpillars feeding on fir.

Amorbia humerosana Clem.

The larvae of this species were collected at Berwick in September of 1926 feeding upon apple foliage, and appeared to be typical leaf rollers. These pupated in October and the adults emerged on the 10th and 19th of the following June. The larvae resemble those of *C. rosaceana,* but have a paler head and proshield.

S. W. Frost, in "Journal of Economic Entomology" has a few notes regarding this species as occurring in Pennsylvania, feeding on huckleberry, pine, poison ivy, spice bush; apple is not mentioned. W. T. M. Forbes records it as being generally distributed over New York State.

THE MEXICAN BEAN BEETLE IN ONTARIO

L. S. McLaine, Entomological Branch, Ottawa

At the annual meeting of the Society, held in 1925, the remark was made that scarcely a year elapses without the discovery of some new and important pest. For the most part these pests have been invaders from other continents, but this report of another noxious foe deals with an insect native to the American continent.

The Mexican bean beetle, *Epilachna corrupta* Muls., is a native North American insect having been first described by Mulsant in 1850. According to Chittenden[1] this insect came from Mexico. It was first recognized in the United States in 1864, but nothing appears to have been known concerning its injurious habits until twenty years later when in 1883 it caused serious injury to wax beans in Colorado. This pest has, also, been established in New Mexico, Arizona and western Texas for some years.

In 1920, it was found in the vicinity of Birmingham, Alabama, although subsequent evidence seems to prove that it may have been introduced two years earlier, having apparently been transported into Alabama on shipments of alfalfa hay from beetle infested areas in New Mexico and Colorado. Previous to this "jump" the insect "seems to have been restricted in its spread by surrounding desert and semi-arid range country wherein the necessary food plants did not occur through long distances."[2]

After becoming established in Alabama, it spread rapidly and by 1921 all the beans in an area covering 4,500 square miles were destroyed. Quarantines were placed on the infested areas by both the state and federal governments in an attempt to retard distribution and spread, but these were later rescinded on account of the rapid dissemination of the insect by flight. By the fall of 1921, in addition to Alabama, portions of Georgia, North and South Carolina, Kentucky and Tennessee were infested. In 1922, Virginia was invaded, and in 1923 portions of Mississippi and south-

[1]F. H. Chittenden, U.S. Farmers Bulletin 1074, November, 1919.

[2]F. L. Thomas, Life-History and Control of the Mexican Bean Beetle, Bulletin 221, 1924, Agricultural Experimental Station, Auburn, Alabama.

ern Ohio were included in the infested area. The following year, 1924, the beetle had reached the southern shores of Lake Erie in Ohio and also the States of Indiana, Pennsylvania and West Virginia. The year 1925 saw Maryland added to the list, and although no new states were added in 1926, there was a general spread in those which were infested. Apparently 1927 was a year of unusually heavy flight and spread, for in addition to the States of Michigan and New York being invaded, the insect crossed the international border and was collected at a number of points in Ontario.

With the appearance of the Mexican bean beetle on the southern shore of Lake Erie in the late summer of 1924, plans were made by the Dominion Entomological Branch to carry on scouting in the bean growing sections of southwestern Ontario in 1925, as it was anticipated that with favorable winds the insect would soon cross the lake. No sign of the insect was found during that year nor in the summer of 1926 when scouting was continued. On July 20, 1927, a collection of larvae was taken by Mr. C. S. Thompson, in a large field of beans at Cedar Springs, Kent County, about twelve miles south of Chatham. Further scouting was continued until late August, during which time a total of 369 farms were visited, and twenty-one collections of the insect were made, including all stages of its life history.

According to reports of the inspectors, the intensity of the infestation varied greatly, but, in all fields found infested in the extreme southwestern portion of the province, it was possible to find several infested patches distributed throughout the field, from two to fifty plants being attacked in each spot.

One or more infestations were found in the following townships: Camden, Chatham, Harwich, Howard, Orford, Raleigh, and Zone in Kent County; Colchester South and Mersea in Essex County; Southwold in Elgin County; Etobicoke in York County and Nelson and Trafalgar in Halton County.

Mention should be made of a report received during the winter of 1927, to the effect that two adults of the Mexican bean beetle were collected on grass beside a lake near Plevna, Clarendon township, Frontenac County, during summer of 1926. This area was investigated in 1927, all bean patches in the vicinity of the reported capture being visited, but no sign of the insect was found.

It is impossible to predict what the insect may do under Canadian conditions. According to Hinds, it is said to live at an altitude up to 7,000 feet and in winter temperatures as low as thirty degrees below zero. Reports from infested states indicate severe damage wherever the insect is present in any numbers, and in Ohio[3] total losses to both field and lima beans are reported.

The insect has a wide range of food plants. Howard[4] states that it is primarily a bean pest, preferring the common bean and the lima bean to other plants. Its second choice is beggar weed or beggar tick. It can live successfully on cowpea, and soy bean, and attacks hyacinth bean, adsuki bean, alfalfa and sweet clover; the latter, however, is not considered a desirable plant. When bean foliage is scarce the insect will feed on velvet bean, kudzue, crimson clover, white clover, corn, grasses, okra, egg plant, potato, squash, mung bean and some weeds.

[3]Monthly Bulletin, Ohio Agricultural Experimental Station, November-December, 1924.

[4]Neale F. Howard, "The Mexican Bean Beetle in the East." Farmers Bulletin, 1407, United States Department of Agriculture, May, 1924.

The presence of the pest in Canada is most unfortunate, especially in the Province of Ontario, where beans are a most important crop. According to the Canada Year Book (1926), in 1925 there were 81,466 acres of beans planted in Canada and the value of the crop was $3,876,600; 61,080 acres were in Ontario with a value of $2,836,000.

L. CAESAR—I would like to ask Mr. Howard whether in his application of arsenicals the dust method of applying was as satisfactory as the spray?

N. HOWARD—In our experiments dusts have not given the perfect control that sprays have. However, I presume that over the infested territories dusts are used more than sprays. We make both recommendations to the grower and allow him to choose according to his needs.

L. CAESAR—Do you find less burning from the dust than from the spray?

N. HOWARD—Apparently a crop of beans will stand more arsenical per acre as a dust than as a spray. However, lead arsenate, zinc arsenate or calcium arsenate without excess of lime will burn as a dust almost as they would as a spray without lime.

L. CAESAR—How many applications are found necessary?

N. HOWARD—The maximum is five under the most severe conditions but these conditions do not always exist and sometimes we dust only once; sometimes twice or three times.

H. G. CRAWFORD—May I ask when five applications are necessary? Are these necessary to kill adults and larvae that were missed in the preliminary dusting?

N. HOWARD—Because bean crops only require forty-five days for maturity and the foliage grows so rapidly that the new foliage is required to be covered.

MR. HOPPING—Mr. President, I was just wondering if anyone had made any surmise or guess as to why this Mexican bean beetle should suddenly spread over the United States.

N. HOWARD—The reason is that it made a so-called commercial jump from the west to north Alabama, probably in freight cars loaded with alfalfa hay being shipped to the east during the war.

A. GIBSON—Have you any records as to how far the beetle will fly?

N. HOWARD—I know of a flight of five miles, but I believe that Mr. Douglas in New Mexico, who is in charge of the laboratory there has better records than that. Observations there prove that flights of 10, 15, or 18 or more miles are made in the fall and spring. In that area the bean beetle flies to the valleys and hibernates in the scrub. We think that most of this spread in the United States has been natural spread, though aided by commerce. Wind is a factor in natural spread.

SOME NOTES ON THE LIFE-HISTORY OF THE MEXICAN BEAN BEETLE IN ONTARIO*

H. F. HUDSON AND A. A. WOOD,
DOMINION ENTOMOLOGICAL LABORATORY, STRATHROY, ONTARIO

These notes cover some observations on the life-history of the Mexican bean beetle, *Epilachna corrupta* Muls. which were carried on at the Dominion Entomological Laboratory, Strathroy, Ontario, during the year 1927.

*Contribution from the Division of Field Crop and Garden Insects, Entomological Branch, Department of Agriculture, Ottawa.

The insect was first discovered in Canada by Mr. C. S. Thompson, of the Division of Foreign Pests Suppression, while scouting for its possible occurrence in Canada. Material for the study was obtained from bean fields at Leamington, Ontario, August 4, 1927.

Most of the insects found in the field at this time were in the pupal stage and emerged as beetles on August 9. Egg laying began on August 10, and the egg laying capacity of one female kept under close observation was found to be 656 eggs during her life time. The eggs were laid in clusters on the underside of the bean leaf, and varied in number per cluster, from 2 to 74, the average mass containing 45 eggs. The eggs, orange yellow in color and slightly sculptured, hatched in from 7 to 14 days.

The larvae moulted three times, and the average duration of each stage for the late summer proved to be,—for the first instar, 8.5 days; for the second instar, 5.5 days; for the third instar, 6.25 days; and for the fourth instar, 9.75 days. The average duration of the pupal period was 12.5 days. The whole period from egg to beetle at this season was approximately 51 days.

When the beetle emerges it is light lemon in color, without markings, but in less than an hour, the characteristic spots begin to appear. The beetle gradually becomes darker in color, so that in a week to ten days after emergence, its color has changed from the lemon to a definite copper. The beetle may be recognized by its general color and the eight black dots on each elytron.

Beans appear to be the preferred food plant, although the beetles will feed to a slight extent on alfalfa. The larvae skeletonize the under surface of the leaf, leaving the upper surface intact. The beetles, however, also feeding from below, eat out ragged areas in the lower surface of the leaf, and by cutting through the upper surface, give the foliage a lace-like appearance.

There are probably two broods a year, the winter being spent in the adult stage.

LATEST DEVELOPMENTS IN THE CONTROL OF STORED PRODUCT PESTS WITH CALCIUM CYANIDE

C. H. Curran

During the past year investigations conducted with calcium cyanide as a fumigant for stored product insects in Canada lead to the conclusion that the use of this substance as a fumigant is both efficient and economical. In recommending the use of calcium cyanide as a fumigant a year ago the use of damp and dry newspapers to be used in distributing the dust was contained in the directions for application. Up to that time no opportunity to test the substance in a large commercial plant had presented itself and it is interesting to note that in large buildings the paper may be eliminated and the dust broadcast over the floor and machinery by means of a shovel. The saving in time is very great and the distribution of the dust into corners facilitated.

Since the use of calcium cyanide is likely to increase greatly as a fumigant, it becomes necessary to issue a warning to all who are likely to employ it, inasmuch as there is unquestionably a great deal of danger involved in this method of control. The greatest danger connected with calcium cyanide is to be found, not in the dust or fumes, but in carelessness or ignorance of the operator, since the use of only certain types of calcium

cyanide is safe under indoor conditions. Calcium cyanide, as prepared today, consists of two rather extreme forms, each having a different use. One of these gives a maximum concentration of gas in from six to seven hours and is ideal for indoor work, while the other extreme gives its greatest concentration in about thirty minutes and is used for field fumigation. With this latter type sufficient gas is given off in a few seconds to saturate the air of a room to such an extent that, unless one were standing very close to the exit it might be impossible to escape before inhaling a lethal dose. Where maximum concentration is not reached until several hours after distribution there is little danger of being overcome and, while it is urged that the application be carried out quickly, there is no need of haste of such a nature as might result in an uneven distribution of the material. Undoubtedly calcium cyanide giving a maximum concentration of gas in seven or eight hours from the time of exposure to the air, is by far the safest means of employing the deadly gas as a fumigant indoors.

In buildings where there are rugs, curtains, etc., these should be removed before fumigation, since hydrocyanic acid has a tendency to bleach materials colored by certain dyes. Whether or not this action would be very noticeable from the gas alone is a question I am unable to answer but the contact of the dust with such material would undoubtedly result in discoloration.

The experiments conducted during the past summer would seem to indicate that, under favorable conditions, all stages of insect life are destroyed. In samples taken from flour mills no living specimens of the lepidopterous pests were found in the flour after five months from treatment, while the checks showed conclusively that adult insects developed in that time from eggs as well as larvae present at the time of fumigation.

It is undoubtedly true that Coleopterous insects are much more resistant to fumigation (as well as superheating) than are the Lepidoptera. The latter may be destroyed with a dosage of one and one-half pounds of calcium cyanide per one thousand cubic feet, but in order to secure complete results, including the destruction of beetles, it is necessary to use two pounds of coarse grade calcium cyanide per one thousand cubic feet.

A CHEAP AND EFFECTIVE FLY SPRAY*

C. R. TWINN, ENTOMOLOGICAL BRANCH, AND F. A. HERMAN,
DIVISON OF CHEMISTRY, CENTRAL EXPERIMENTAL FARM, OTTAWA

This paper dealt briefly with the desirability of controlling flies infesting houses and other buildings, particularly the housefly, *Mucsa domestica* L., and presented the results from a series of experiments conducted with fly sprays of various formulae at the Central Experimental Farm. Spray mixtures consisting essentially of pyrethrum extract and kerosene were found to give the best results, for all practical purposes a 6 per cent. pyrethrum-kerosene spray proving quite satisfactory. This is prepared by adding one-half pound of pyrethrum to one gallon (8.08 lbs.) of kerosene, allowing the mixture to stand and agitating it at intervals over a period of about two hours, thus ensuring that practically all the active principle of the pyrethrum is dissolved. The residue of the pyrethrum settles to the bottom of the vessel as a brown sediment, and the clear liquid, which is pale lemon-yellow in color, may either be siphoned or filtered off. When the spray is required for use in farm buildings, it may be satisfactorily

*The full paper has been submitted to *Scientific Agriculture* for publication.

prepared with ordinary kerosene and it is unnecessary to add any other chemicals. For household use, however, to remove any possibility of staining fabrics or furniture, water-white kerosene should be used, and, in order to impart a pleasant odor, methyl salicylate may be added at the rate of three fluid ounces to each gallon. The spray should be kept in a tightly corked container to prevent it from deteriorating in strength, as the active principle of pyrethrum is volatile. Three-quarters of a fluid ounce of spray are required to treat each thousand cubic feet of space, the materials being sprayed in the form of a fine mist. In using this spray it is advisable to sweep up the dead and dying flies shortly after the application and to either burn them or throw them into hot water, as otherwise a certain percentage is liable to recover.

This spray should find wide application wherever flies are troublesome under indoor conditions, such as in cattle barns, stables and unscreened houses, and, as it has been observed to kill other species of insects, it should also prove useful in destroying other household insect pests.

CAESAR—Does the spray have to be made up long before use?

TWINN—It is only necessary to allow the pyrethrum to stand in the kerosene for two hours and to agitate it occasionally. It is then ready to use. From experiments it appears that there is no advantage in allowing the pyrethrum to stand in the kerosene for twenty-four hours or longer.

PRESIDENT—Would the spray keep in a closed container?

TWINN—It is always advisable to keep it in a tightly corked vessel. I know people who have used some of the proprietary fly sprays and after keeping them in the house during the winter have found them of little use in the spring.

CAESAR—Is there any precaution necessary in the buying of pyrethrum?

TWINN—The pyrethrum should be fresh. I have had no trouble with the pyrethrum purchased by us.

PRESIDENT—Did you try out this mixture in a dairy barn where it might impart some odor to the milk?

TWINN—I did not, but at the Experimental Farm they use spray for stable flies and horn flies that attack cows while in the barn. Apparently they have no trouble from the use of this, so I feel safe in saying that there would be no trouble in this respect resulting from the use of pyrethrum kerosene spray.

CAESAR—Did you find any difference in the susceptibility between the house fly and stable fly?

TWINN—It appears to be equally effective against both species. We also found ichneumons, blow flies and other insect species among the dead flies, but the majority were house flies.

GORHAM—Does the spray leave any stain?

TWINN—Mr. Herman tested the spray prepared with water white kerosene and found there was no stain from it at all.

MOSQUITO CONTROL ACTIVITIES IN WESTERN CANADA

Eric Hearle,
Dominion Entomological Laboratory, Indian Head, Saskatchewan

Introduction

The last paper that the writer submitted to the Entomological Society of Ontario was published in 1921. It dealt with some mosquito problems of British Columbia, and mainly with the results of an investigation of the mosquitoes of the Lower Fraser valley. Since that time a detailed investigation of the mosquitoes of the Rocky Mountain Park in the vicinity of Banff has been completed; studies of the biology of the main prairie species have been carried out in Saskatchewan and Manitoba; and a number of minor problems have received attention elsewhere.

The rapidly increasing tourist trade is responsible for much of the interest that is being shown in mosquito control activities in Western Canada. About a quarter of a million tourists visited the western national parks and adjacent scenic places in 1927. An increasingly large number of tourists utilize auto camps, and in many sections mosquitoes render otherwise attractive places almost untenable. Mosquito control, therefore, has become much more necessary than was the case before auto touring was so much in vogue.

Mosquitoes were, indeed, very numerous in many parts of western Canada in 1927, and interest in the possibility of their control is very apparent at the present time. Considerable publicity has been given to the results obtained at Ottawa, Winnipeg, Banff and elsewhere, and the public generally are realizing that mosquitoes are not an incurable pest.

From an agricultural viewpoint mosquitoes are undoubtedly a serious pest in many sections of the western provinces, especially in dairy and live stock districts. Lessened milk production and poor condition result from severe mosquito attacks. The present season (1927) with its excellent pasture conditions and abnormally high mosquito production demonstrated these points very forcibly.

Development in the Lower Fraser Valley Problem

A three years' investigation of this problem was completed in 1921 and the results have been published as Report 17 of the National Research Council. Since 1921 the Sumas dyke has been completed, a reclamation scheme reducing by more than one half the flood water breeding areas in the Lower Fraser valley. In addition to the above a dyking scheme embracing 1,400 acres has been completed at South Westminster, and another project embracing 600 acres will probably be undertaken early in 1928 at Fort Langley. This leaves about 8,000 acres of flood water breeding area in the Lower Fraser valley as against the huge areas that occurred prior to 1921. The problem is becoming much more restricted and the possibility of an organized program of control is much more feasible than was the case a few years ago. Residents in the vicinity of Sumas have attested to the extraordinary reduction in the mosquito pest in that district since the dyking was completed.

While little has been attempted over much of the valley in the way of control by oiling; a good demonstration has been given of the feasibility of oiling methods under the very difficult conditions obtaining in the district. Mr. R. Glendenning of the Dominion Entomological laboratory at Agassiz undertook the supervision of control work at Harrison Hot Springs during

1926 and 1927. A system of trails was cut in the dense cottonwood brush and oiling operations were undertaken in an efficient manner. Excellent results were obtained at a very small cost. The work will probably be somewhat extended to cope with migrations from beyond the area at present under control.

The Interior of British Columbia

Kamloops Mosquito Pest—Mosquitoes have been very troublesome at this point due mainly to the flooding of breeding areas at the freshet of the Thompson river. Some of these flood areas are open flats and others are brush covered—they are mainly too narrow for economical dyking. *Aedes hirsuteron, Aedes vexans, Aedes punctor* and *Aedes dorsalis* are four of the more important species observed here. It is probable that the last mentioned species breeds to some extent in the irrigation pools.

Oiling operations have been carried out by the Kamloops city council from 1925 on, and have been very successful, except during the present year, when the appropriation was small and the conditions exceptionally difficult to deal with owing to a very high freshet.

Interest is being shown in the possibilities of controlling the mosquito pest at Tranquille, the site of the government pulmonary sanitarium, which lies in the same valley as Kamloops, and has much the same conditions with which to contend.

The Eagle Valley Mosquito League—This league was formed in 1925, when the sum of $1,000 was raised for the purpose of combating the serious mosquito nuisance occurring in the Eagle valley from Sicamous East to Craigellachie. The mosquitoes develop in the flood pools from the freshet of the Eagle river and the rise of Sicamous Lake. The river bottom lands are densely clothed with alder and heavy underbrush, and numbers of old beaver dams complicate matters. There are also small areas of muskeg. The important species are *Aedes hirsuteron* and*Aedes vexans; Aedes punctor* and *Aedes cinereus* are also common. The control operations, commenced in 1925, are said to have met with considerable success, and the secretary of the local farmers institute informs us that dairy animals have responded favorably and that there has been a marked improvement in the milk yield.

The Kelowna Mosquito Pest—Mosquitoes have been a fairly serious pest in this city and its environs, and a very attractive municipal park, bathing beach and auto camp have been especially badly affected owing to the proximity of many sloughs and low places, which fill with water at the rise of the lake. *Aedes vexans* is one of the most troublesome species in this district.

Control operations have been carried out by the city council with considerable success since 1923; systematic oiling being undertaken over all seepage, flood and surface pools within the city limits. Four oilings are made each year. In addition to this a definite program of permanent improvement has been drawn up and low places and sloughs are gradually being eliminated by fillings; a large quantity of sawdust being available for this purpose from local lumber mills. Reports indicate that the best of results have been obtained, and during the present season, when many outside districts were very badly infested, comparative freedom was experienced in the city. Even better results could be realized however if adjacent municipalities with extensive breeding areas would co-operate with the city council.

The Trout Creek Mosquito Pest—This is a small very localized project which has some features of considerable interest. A much silted up creek

causes flooding in this vicinity at freshet time. A number of beavers made this point of land their home and by damming up the creek extended the flooded areas. Not much systematic control work has been attempted beyond a little general oiling.

The Mosquito Situation in the Southern Okanagan Valley—This semi-arid valley does not look like the type of place one associates with mosquito pests, but the Okanagan river, which traverses it, has a considerable area of scrub covered bottom land on each side, and in places where this is wide, mosquitoes are a serious nuisance following flooding at freshet time. Wide areas of flooded meadow also occur at a few points. *Aedes vexans* is one of the dominant species and *Aedes hirsuteron* is undoubtedly an important constituent of the pest. Our knowledge of the mosquito fauna of this district is, however, somewhat meagre. *Anopheles* develop more extensively here than elsewhere in British Columbia, the common species being *Anopheles maculipennis.* Irrigation will doubtless further complicate the situation. The district has been brought into prominence on account of the extensive irrigation project, undertaken by the provincial government, opening up a very fertile area for fruit farming. Development is proceeding with remarkable rapidity. Little control work has been attempted so far in this district, but a great deal of interest has been evinced as to the possibilities of reducing the pest.

Creston Mosquito Pest—A very serious mosquito pest occurs in the Kootenay valley in the vicinity of Creston, and the live stock and small fruit industries suffer considerable losses. Advices during the present season indicate that the pest was unusually severe. A most interesting old book—Lee and Clutterbuck's "Rambles in British Columbia in 1887" gives a very graphic and amusing account of the mosquito nuisance in this vicinity. The Kootenay Flats, an enormous area of 100,000 acres are subject to flooding at freshet time, owing to the narrow outlet of the Kootenay Lake. There is no doubt that the main mosquito pest is developed here and that *Aedes vexans* and *Aedes hirsuteron* are the dominant species. Various schemes to reclaim this area have been discussed for 40 or 50 years, and recently about 30,000 acres have been reclaimed on the United States' side of the valley. So far the reclamation of the 45,000 acres on the Canadian side of the boundary has got little further than the preparation of engineers' plans, but it is hoped that the difficulties in connection with the project will soon be overcome and that this wonderfully fertile land will be put to a better use than the production of several thousand tons of wild hay and an enormous crop of bloodthirsty mosquitoes. There has been a great deal of agitation for mosquito control from this point.

Tourist Resorts in the Alberta Mountains and the Yukon Territory

Banff Mosquito Control Project—A very serious mosquito pest occurred in this vicinity and materially reduced the attractiveness of what is undoubtedly the most important tourist resort in Canada. At one time mosquitoes used to drive away numbers of visitors from this resort. A detailed investigation of the situation was made from 1922 to 1925, and systematic oiling and other control methods were put into operation by the Dominion Parks Branch, under the supervision and guidance of the Entomological Branch. Three separate problems are encountered in this district—control of the mosquitoes breeding in the snow pools formed in April and May; in the rain pools of late spring; and in the much more extensive flood pools formed by the freshets in June. The nature of the country is such that many difficulties are encountered in carrying out a program of systematic oiling. There are large areas of brush in which the

willow and underbrush were found to be so dense that a system of trails was necessary before oiling was possible.

The main species in the Banff district are *Aedes cataphylla, Aedes intrudens and Aedes vexans,* although a few others of the 24 species in the district are of some importance at times.

Oiling has been carried out since 1922 over a district of about 4 by 2 miles, involving about 1,400 acres of breeding area. These operations extend from May to July, several oilings being needed, and some 2,500 gallons being used annually. Since the work was commenced almost perfect control has been realized except for two short periods when a little trouble occurred owing to very adverse conditions, during which periods of heavy floods synchronized with almost continuous rains. The total expenditure for oiling, cutting trails, ditching and other permanent work amounts to about $3,000 annually and this appears to be a very modest sum when one realizes that some 124,000 tourists utilized the park in 1925, that the number is increasing greatly each year, and that each tourist represents a good many dollars profit to the community.

Lake Louise Mosquito Pest—Investigations of this pest were made from 1922 to 1925, and the problem was found to be far simpler than that at Banff. There is no flood area involved and very little trouble occurs from summer rain pools. The main pest develops from pools formed by the melting snow. *Aedes cataphylla, Aedes intrudens, Aedes punctor* and *Aedes pullatus* are the species of major importance. A little control work has been attempted here but this proved ineffective owing to the inadequate knowledge of those in charge.

Mosquito Pest at White Horse, Yukon Territory—On account of the growing tourist trade some interest has been evinced in the possibilities of controlling the mosquito pest in this vicinity. Dr. Dyar has studied the mosquito fauna here and has found *Aedes cataphylla* to be the dominant species, with *Aedes campestris, Aedes communis* and *Aedes punctor* also common. The problem is evidently one that could readily be dealt with by systematic oiling, as it appears to be very similar to the early snow pool problem at Banff, in which practically 100 per cent. control has been realized during the last six years. A number of attempts have been made by individual residents of White Horse to lessen the nuisance and these have met with a certain measure of success, but no extensive systematic oiling program has yet been undertaken.

The Mosquito Nuisance in the Prairie Provinces

Reports from a number of points throughout the Prairie Provinces indicate that the mosquito pest was far more serious in 1927 than had been the case for many years, owing to the abnormally wet season. According to some of the correspondence from practical cattle men, live stock did not pick up in the way they should have done in consideration of the excellent pasture conditions; and in the worst affected districts, a reduction in milk flow from dairy animals was evident.

Mosquitoes in the Irrigated Sections of Montana and Alberta—An investigation into the mosquito pest in the Milk River valley in Montana is being undertaken by the Entomological Department of the Montana Experiment Station, and the writer looked over the situation during the present year at the request of the officials of this station. The irrigated alfalfa and blue joint meadows are the main source of the pest, which increases throughout the season and continues into September. Each irrigation results in the hatching of a fresh batch of mosquitoes, and *Aedes*

dorsalis, Aedes nigromaculis and *Aedes vexans* are the main species breeding in pools formed by irrigation water.

Conditions in the irrigated sections of southern Alberta are somewhat analagous to those in the Milk River valley, Montana, and mosquitoes are very troublesome at times. Some 300,000 acres of irrigated land are in use at present, although nearly three times this amount are available under existing irrigation projects, according to figures from the Canadian Pacific Railway Company. Nothing in the way of an adequate survey of mosquito conditions has been attempted, but incidental collecting indicates that *Aedes vexans, Aedes dorsalis* and *Aedes nigromaculis* are the major species, as in the irrigated district to the south across the border. Through the courtesy of the entomologists in Montana we are keeping in close touch with developments in mosquito investigations in that state.

Investigations of the Bionomics of Prairie Mosquitoes—While stationed at Indian Head, Saskatchewan, during 1926 and 1927 in connection with a survey of live stock insect conditions, the writer carried out studies of the biology of typical prairie mosquitoes. A large number of breeding places have been under observation, collections of larvae and adults have been made and fairly detailed life history studies have been undertaken. The main species under observation have been *Aedes spencerii, Aedes flavescens, Aedes dorsalis, Aedes excrucians, Aedes campestris* and *Aedes nigromaculis.* Several thousand specimens from many points in the three Prairie Provinces have been determined and a paper is under preparation incorporating the information obtained.

In Manitoba, Dr. H. A. Robertson, working under Mr. Criddle at the Treesbank laboratory, added a great deal to our knowledge of the mosquitoes of that province. Collections and surveys of breeding places were made from 1921 to 1923, and in the latter year especially, many rearings were made and notes were secured on the biology of the important species.

Winnipeg Mosquito Control Project—In the spring of 1927 a mosquito control committee was formed in Winnipeg under the chairmanship of Dr. H. M. Speechly with the object of reducing the mosquito pest in that vicinity. The writer undertook a preliminary investigation and acted in an advisory capacity to the committee.

The poor drainage of extensive areas of uncultivated land surrounding the city results in the accumulation of much water during wet seasons, and the problem is one of very considerable magnitude. *Aedes vexans, Aedes hirsuteron, Aedes dorsalis* and *Aedes canadensis* were found to be important species.

Control operations were undertaken by the Mosquito Control Committee, the City Parks Board, various local golf clubs and several railway companies. The efforts of these organizations appear to have met with a considerable measure of success in spite of abnormally adverse conditions. Some 2,000 gallons of oil were applied and the results have been so encouraging that the work will be greatly extended next season.

DR. WALKER—I would like to ask Mr. Hearle whether anything came of the experiment of introducing fish into the affected area.

HEARLE—We introduced a shipment of *Gambusia affinis* which is supposed to be one of the best fish for mosquito control. Some of the fish were placed in warm sulphur water hoping that we should form a nucleus for spreading and we found them producing great numbers in this water. They seem to thrive excellently in any place where sulphur water occurs and the water remains warm. Large numbers were placed in lakes and we hoped the fish would increase sufficiently to spread over the breeding areas during flood time. Unfortunately it

has been impossible to revisit that section and see if these fish have actually become acclimatized in the open waters. We have never been able to find out if they have acclimatized themselves to the cold water.

SPENCER—Has any study been made of the effect of this wholesale oiling on other insects that breed in pools?

HEARLE—From casual observations we know that large numbers of certain insects are killed by oil but going over the area year after year we see no reduction in the insect fauna of that district. Large numbers of dead insects are seen after oiling.

KELSALL—What about the effect on wild ducks and other wild birds?

HEARLE—We have not noticed any trouble in the Banff district and I have never run across that point. The large permanent areas of water which would naturally harbour the wild duck are not oiled. It is just semi-permanent and temporary bodies of water we have to oil and we have never noticed any trouble there of that kind.

FIELD CROP INSECT CONDITIONS IN SASKATCHEWAN, 1922-27*

KENNETH M. KING, SASKATOON, SASK.

SUMMARY†

A general survey is given of insect pests affecting Saskatchewan field crops. The average annual value of the production of such crops in this province approaches three hundred million dollars. During the six year period, considering the province as a whole, the major insect pests were (1) the western wheat-stem sawfly, (2) wireworm, (3) cutworms, and (4) grasshoppers, listed in their estimated ranking from the viewpoint of crop losses which they caused. A total of more than nineteen million dollars is estimated as the crop loss caused by the major insect pests of 1926, the corresponding total for 1927 being less than half of that amount; these figures probably represent the two extremes during the period.

The area in which "commercial" damage by the wheat-stem sawfly (*Cephus cinctus* Nort.) occurs, has shown a considerable increase in recent years. The actual damage has varied markedly from year to year; a maximum occurred in 1926. *Ludius aereipennis tinctus* Lec. and *Cryptohypnus nocturnus* Esch. were the principal of several species of wireworms involved in important annual destruction of crop. The red-backed cutworm, *Euxoa ochrogaster* Gn. was the outstanding cutworm of economic importance. This species caused important field-crop injury each year from 1923 to 1926, reaching a climax in 1925. From 1925 to 1927 the pale western cutworm, *Porosagrotis orthogonia* Morr. was destructive in southwestern and south central Saskatchewan, the latter area representing a marked extension of the economic range of the species. Grasshoppers were troublesome only during the first two of the six years under review.

Several outbreaks of minor species occurred. *Barathra configurata* Wlk., the "bertha" armyworm, was abundant in some part of the province each year since 1922, seriously injuring flax, sweet clover, alfalfa, cabbage and corn. In 1923 there was a rather local but severe outbreak of the northwest chinch bug, *Blissus occiduus* Barber, and in 1924 an outbreak of

*Contribution from the Division of Field Crop and Garden Insects, Entomological Branch, Department of Agriculture, Ottawa.

†The full statement has been submitted to *Scientific Agriculture* for publication.

the six-spotted leafhopper, *Cicadula sexnotata* Fall. The Hessian fly, *Phytophaga destructor* Say, was rather troublesome in some areas during several of the years, particularly 1927. During 1923, 1926 and 1927, the English grain aphid, *Macrosiphum granarium* Kby., was widespread and abundant during the late summer.

A number of other insect species caused a relatively small amount of damage to field crops in various years, or aroused considerable interest because of their abundance in fields in crop.

THE CORN BORER ACT IN OPERATION

PROF. L. CAESAR

It is not my intention in this paper to discuss the Corn Borer Act itself nor the regulations under it but merely to give you a general idea of how the Act has worked, the difficulties met with, the results obtained and suggestions as to how the control operations may be improved.

AREA UNDER THE ACT THE FIRST YEAR

The Act was put into operation for the first time in the fall of 1926. Only eight counties were put under it the first year. (Other counties had the privilege of coming under if they wished but none did so.) The eight counties were Essex, Kent, Lambton, Elgin, Middlesex, Oxford, Norfolk and Prince Edward. Of these the first seven were the worst infested in the province and formed a solid block, a very important fact as any work done in one county would thereby help another. Prince Edward was included because it is a great canning corn centre, and, due to its position, largely isolated; so that it did not stand in much danger of being reinfested from its neighbors. The reason for not adding more counties was that it seemed wise to limit our work the first year, so that we might be able to concentrate our efforts better and gain the necessary experience to enable us to handle effectively larger areas later.

THE INSPECTORS

The success of any Act depends of course largely upon the inspectors who enforce it; hence I took great pains to impress upon the county councils the necessity of appointing none but the best men available as inspectors. I am glad to say that they nearly all followed this advice and we have about as good a set of inspectors as one could expect.

Once the inspectors were appointed, the next step was to train them, first, by familiarizing them with the habits of the borers themselves and then by pointing out what seemed the best methods of performing their duties. Some of them, namely, the men from Norfolk, Oxford, Middlesex and Prince Edward had never seen a really badly injured field; so these, along with the wardens of their respective counties, were brought to Kent County to see some of the devastated area and thus realize for themselves what a dangerous foe they were helping to combat.

The inspectors began their work about the first of September. Most of their duties in the autumn were of an educative nature, namely; letting the farmers know that the Act was in operation in their respective counties, pointing out what it required of them and how they could with the least labor or trouble comply with its regulations. In this way and by notices in the local press, by posters and by distributing copies of the Act

itself, almost every corn grower in the eight counties was reached. In this educative campaign the inspectors were assisted in various ways by the Dominion Entomological Branch, the Agricultural Representatives and by Mr. Marshall, my assistant, and myself. There is not time, however, to give details of how this was done.

Difficulties Encountered

As the main work of enforcing the Act took place during the spring naturally any difficulties that arose were during that period. One of the greatest of these difficulties, or causes of difficulties encountered, was that the excessively wet autumn in 1926 had made it impossible in most cases to do any fall plowing of cornfields or even of other fields, hence this made the farmers exceedingly busy in the spring and almost overworked.

A second difficulty was that it took a good deal of time and firmness on the inspectors' part, especially in some counties to get the farmers to grasp the fact that the Act was really going to be enforced. However most of them gradually did realize this and fell into line but in some instances an example had to be made of the most obstinate offenders by summoning them before a magistrate and having them fined (I may add here that so far not a single case in court has been lost by us).

A third difficulty was that in spite of the educational campaign many men through obstinacy or conceit or some other cause plowed their fields poorly or else dragged the stubble nearly all up when cultivating or sowing and then had to pick this off, usually by hand, and burn it. This they found a very hard job and one that they disliked greatly but it speaks well both for the inspectors and farmers that it was done as thoroughly as it was.

A fourth difficulty was that on the urgent request of many farmers, especially in Essex, Kent and Lambton, it was felt wise not to make plowing of all corn fields compulsory the first year but to give the men who objected to plowing the option of working their fields up with a disc, then sowing them and then picking off and burning the debris. In some cases, especially where the stubble was long or did not break off or pull up with a disc, the gathering of it was almost an impossible task and so considerable leniency had to be shown.

A fifth difficulty was that the regulations did not make very clear whether the inspector could compel a man to pick off and burn the dragged up stubble or other debris before May 20th. Hence quite a few persons kept putting off this work in a way that was annoying to the inspectors and that aroused criticism. This weakness in the regulations has now been remedied by an Order-in-Council which requires that such stubble and debris be gathered and burned within ten days after it is dragged up or the crop is sown.

A sixth difficulty was that neither myself nor my assistant, Mr. Marshall, nor the inspectors had had enough experience to know the simplest or quickest way of cleaning up a field of standing corn or even of dealing with long stubble so as to make a thorough job of plowing and, where stubble was dragged up, we were not quite sure of the best method of gathering it. However, last spring's experience has taught us a good deal about these points and we have also learned a lot from some experiments conducted this fall; so that next spring we shall be in a much better shape to advise the farmers on these points.

The last difficulty I shall mention is that the inspectors were under a handicap that most of them had had no experience in legal matters and so

felt timid about prosecuting a man; in fact, in many cases prosecutions should have taken place much earlier than they did and too many warnings were given. However, the inspectors have gained confidence and I think there will not be nearly the same amount of hesitation about such matters next year.

In spite of all this and other difficulties or handicaps the clean-up, though in several counties far from perfect, was on the whole much better than I or anyone who knew the obstacles to be overcome had hoped for. We were late, it is true, in getting it completed—about June 20th—but so far as I could discover every man in the eight counties made at least an effort to comply with the Act; in fact, I feel proud of the spirit shown by the great mass of the farmers, of the serious way the inspectors took their work and of the hearty assistance and encouragement given them by the local agricultural representatives.

Results Obtained

It is impossible to give the exact results obtained in each county from the first year's operation of the Corn Borer Act without having spent a great deal more time both in 1926 and 1927 in scouting and dissecting corn plants than was possible. Nevertheless I feel almost sure that the estimates given below are conservative.

In Essex and Kent there was a decrease in the number of borers of at least 50%; in Elgin a decrease of 20%; in Norfolk a decrease of 30%; in Oxford a decrease of 20%; in Lambton an increase of at least 33%; in Middlesex an increase of probably 25%; in Prince Edward an increase of probably 30%.

Unfortunately it was difficult to estimate at all accurately the increases because these all took place in counties where very little scouting had been done the previous year; hence the most I have done is to give rough approximations. Much more data was available for the five counties in which the decreases took place.

From the above it will be seen that in five of the counties there has been an average decrease of about 33% and in the other three counties an increase of probably about the same proportions.

The question then naturally arises—Why the decrease in the five counties and the increase in the other three. It is impossible to answer definitely. I know however that for several reasons, which it is not necessary to go into, the clean-up work in the three counties was not so good as in the others; so this will partly account for the difference. Then, too, it is reasonable to suppose that there was a large migration of moths with the prevailing winds from Essex and Kent to Lambton and the west half of Middlesex, the part of that county in which the increase almost all took place. There is also a possibility that weather conditions in the two most southerly and so earliest counties, Essex and Kent, were less favorable to the borer than in the rest of the counties and so partly accounted for the decrease there. Our experiments in Lambton in larval mortality showed only a normal mortality there of 83%. Moreover there was no evidence that the life of the moths was shorter or that the number of eggs laid per female was fewer than usual. Hence the weather did not favor our work in Lambton and I doubt whether it did in Elgin, Norfolk or Oxford.

Increase in Counties Not Under the Act

Once more our estimates are only rough approximations but there is very little doubt that they are too low rather than too high.

An examination of 40 representative fields in all parts of each of the following counties gave the present infestation: Haldimand 21.9%, Welland 41.1%, Wentworth 22.1%, Brant 15.6%. In Lincoln only 27 fields were scouted, all of them being in the part below the escarpment. These gave an average of 42.7%. The early fields in this area average 77.0%.

The above figures show that Haldimand (21.9%) and Wentworth (22.1%) are now each twice as heavily infested as Norfolk (10.1%), though last year not nearly so heavily; that Brant, in which there was only a light infestation in 1926, has now an average of 15.6%, which is approximately the same as in Oxford; and that Welland and half of Lincoln are now among the most heavily infested areas, having a higher percentage than Elgin. Judging from what has happened in the above five counties and what I saw in most other counties where the borer has been present for some years I feel sure that in the parts of the province not under the Act the borer has increased at least 100%.

When we compare what took place in the eight counties under the Act with what took place in the rest of the province and remember that it is possible to improve our methods and get a much better clean-up than last year we seem justified in feeling very hopeful of ultimate success in the control of this great pest.

Other Counties Brought Under the Act

The great increase of the borer as revealed by scouting this fall made me feel it my duty to bring in much more territory than I had anticipated; so the Act has now been made operative in all that part of the province south of a line from Goderich to about eight miles north of Toronto and also in an area about six miles wide all along Lake Ontario from Toronto to the east boundary of Hastings.

Improving the Clean-up Methods

If we are to continue growing corn we must not only have the Corn Borer Act well enforced but must at the same time make it easier for the farmer to comply with the Act. Otherwise they will give up corn and substitute for it sweet clover and alfalfa or some other crop. The most burdensome feature of the Act at present is the necessity in so many cases of a lot of picking off of stubble and debris after sowing the field in spring; so we must experiment and find out simple and effective methods by which the farmers can so treat their stubble and plough and cultivate their fields that all corn remnants on them will remain completely buried. I am glad to say that a good program of such experimental work is now being carried out jointly by my assistant, Mr. James Marshall, and Mr. Crawford's assistant, Mr. George Stirrett. Some results of real value have, I believe, already been obtained, though the work is not yet completed. New implements or new attachments for old implements in addition to those already devised will probably be invented soon in the United States. Some of these will probably be adopted by a few of our growers but the majority will not buy any expensive new implement for corn alone, and so we must rely on simple home-made devices. Fortunately these seem likely to be sufficient for our purpose.

I may say in conclusion that there are some other aspects of the work under the Corn Borer Act to which I should have liked to call your attention, and also to mention some further lines of investigation which seem to me necessary, but there is not time to do so.

PARASITES OF THE EUROPEAN CORN BORER

D. W. JONES, ASSOCIATE ENTOMOLOGIST, ARLINGTON, MASSACHUSETTS

Parasite work on the European corn borer has developed in a very healthy manner since Dr. Howard instigated the work late in 1919. In the time alloted I will attempt to give the outstanding points concerning the six imported species which we feel are firmly established.

Masicera senilis Rond. is one of the tachinids and approximately 15,000 have been liberated. Recoveries have been made at many points in Massachusetts where material has been in the field for several years. No recoveries can be expected from the recent western liberations as yet. This tachind deposits living maggots on the food plant near the corn borer. The maggot locates and enters its host and lives within the live borer. It spends the winter in this way and kills the host usually just before pupation. One or two generations occur depending on host development.

Phaeogenes planifrons Wesm. is our one pupal parasite. Approximately 20,000 have been liberated and recoveries made in Massachusetts. The female oviposits in the corn borer chrysalid or pupa, entering the tunnels to do so. It shortly emerges as an adult, mates and the females live until pupae are available the following year. This species is especially numerous in Italy.

Eulimneria crassifemur Thom. is a true larval parasite. About 35,000 specimens have been liberated in widely separated areas, and many recoveries have been made in Massachusetts and one isolated case in Michigan. This species deposits eggs inside small second instar borers and the host is killed in the fifth instar at the approach of cold weather. A tough cocoon is formed near the host remains and the parasite passes the winter inside, emerging in the spring. This species is apparently most valuable in an area where the borer and parasite both have two generations, but it is present in areas where only one generation is possible.

Dioctes punctoria Roman, is very similar to *Eulimneria,* except that it hibernates inside the host larva and in Europe is most valuable in a more southerly range. Some 9,000 have been liberated and it shows up nicely in Massachusetts.

Microgaster tibialis Nees. is especially valuable in Northern France, is doing well in Massachusetts and has been recovered in Ohio. Approximately 150,000 have been liberated. The female lays eggs within the second instar borers and the host is killed late in the fourth instar. Hibernation takes place within a tough cocoon in the tunnel where the host was killed. The number of generations is apparently dependent on the host development.

Exeristes roborator Fab. This large hymenopteron is one of the external feeding parasites with which you are especially familiar. We have liberated approximately 150,000 and the Chatham laboratory has exceeded this number. This species has been recovered in small numbers at almost every one of the widely spaced liberation points.

These are the oustanding points concerning the six established species. Six more have been liberated, *Zenillia roseanae* B. and B., *Microbracon*

brevicornis Wesm., *Apanteles thompsoni* Lyle, *Macrocentrus abdominalis* Fab., and two species of the genus *Campoplex*. Our climate and type of agriculture may prevent some from ever becoming of economic help, but most of these last mentioned species have been liberated for too short a time to expect results as yet.

I must emphasize that apparently less important species may become of major importance in certain areas and in certain seasons. *Microbracon* has been of extremely great importance in Hungary this season, yet we apparently do not have the same ideal conditions during the critical hibernation period. *Apanteles* is of wonderful value in northeastern France. It remains to be seen whether our climate will furnish as ideal conditions at the critical point in *Apanteles* life history, which is not in the hibernation period at all but during the short period they spend in their cocoons when moisture is very essential.

We wish to emphasize the wonderful cooperative spirit which has developed in corn borer parasite work between the United States and Canada. We will do everything in our power to foster and encourage this cooperation.

THE SPREAD AND DEGREE OF INFESTATION OF THE EUROPEAN CORN BORER IN CANADA, 1927

W. N. Keenan, Division of Foreign Pests Suppression, Ottawa

Records concerning the progress of the European corn borer in Canada have been presented at the annual meetings of this Society since 1920. Each season we have noted advancement of the pest to new districts and in general the degree of infestation in the earlier infested areas has steadily increased. In 1927 further spread was discovered by our scouting staff and, as a result of the special investigations regarding the degree of infestation, there is an encouraging report at last. Reductions were noted in several of the areas in southwestern Ontario where compulsory control was enforced under the direction of the Provincial Entomologist during 1926-1927.

Annual Spread—It may be mentioned that the corn borer is believed to have become established in Elgin County in 1910, but was not discovered until 1920, when nearly three thousand square miles were found infested. The infested area has extended each year and at the end of the scouting season in 1926 the area known to be infested comprised all farming sections of Ontario south of a line from Renfrew to Bruce County as well as an apparent local outbreak in the vicinity of North Bay. In addition, infestations were discovered in the Province of Quebec in three townships opposite Ottawa and in the Counties of Chateauguay, Huntingdon and St. Johns.

In view of the discovery of the outbreak in the vicinity of North Bay, the fact that corn is not an important crop in the northern districts of Ontario, and the difficulty of enforcing a quaratine prohibiting the movement of corn to these districts, it was decided to extend the quarantine to include the northern Ontario areas. Through the revision of the quaran-

tine in April 1927, the area was extended to include the districts of Timiskaming, Sudbury, Nipissing, Parry Sound and all territory located east and south of same in the Province of Ontario, excepting Manitoulin district, as well as the areas in Quebec which were found infested in 1926. The Counties of Elgin, Middlesex, Kent, Essex and Lambton remained under double quarantine.

In 1927 further scouting was carried on by the Federal staff in the Province of Ontario and also in the Province of Quebec in cooperation with the Provincial Entomologist. The results show a continued spread to new districts, as a total of sixty-two collections were made, of which fifty-nine were in districts not previously found infested. The following is a statement of the new areas infested:

ONTARIO—Nine townships in Algoma district, fourteen townships in Manitoulin, three in Muskoka, four in Nipissing, three in Parry Sound, one in Sudbury and two in Timiskaming district.

QUEBEC—In the following number of parishes or townships in the counties stated: Argenteuil (1), Beauharnois (1), Champlain (1), Hull (2), Jacques Cartier (3), L'Assomption (2), Laval (1), Missisquoi (2), Napierville (2), Nicolet (1), Papineau (3), Pontiac (7), St. Johns (1), Two Mountains (1) and Vaudreuil (1).

In regard to the 1927 discoveries, it may be pointed out that the most eastern record was located near the village of Batiscan on the St. Lawrence River in Champlain County, Quebec; the most northern at New Liskeard in the district of Timiskaming and the most western in the township of St. Joseph in St. Joseph's Island, Algoma district, which is approximately fifteen miles east of the city of Sault Ste. Marie. Thus the distribution of the European corn borer extends from east to west, in the Provinces of Ontario and Quebec, for a distance of 575 miles, while in the former province its north to south distribution covers a distance of 385 miles.

Degree of Infestation in Infested Territory

In the districts found infested this year corn borer collections were made, in most cases, only after careful search and in a great many townships the inspectors were unable to discover outbreaks. On Manitoulin Island, however, the corn borer was noted in practically every field visited. These observations would suggest that the rate of increase on the island should be very carefully watched.

In the newly infested area in Quebec Province infestations were discovered with the least difficulty in Jacques Cartier County. As table corn is grown in large quantities in this and Laval County, annual increases may be expected unless control measures are carefully applied.

In the areas in southern Ontario which have been infested for some years, observation points were established to record the annual degree of infestation. The work was first undertaken in 1923 and with the extension of the seriously infested territory, points were established in additional counties; this necessitated a reduction of points in the areas originally under special observation.

The report of this Society for 1926 includes a summary of the records for each season since the work was started and the following table is a summary of the 1927 conditions as compared with those of 1926:

Summary of Corn Borer Infestation Records, 1927

Area	Percent. Stalk Infestation						Total No. of Fields Exam.	
	High		Low		Average			
	1926	1927	1926	1927	1926	1927	1926	1927
Circle No. 1 (6-8 miles)*	82	76	8	4	31	40	30	30
" " 2 (15 miles)	92	100	1	2	39	40	50	43
" " 3 (30 miles)	91	82	2	0	29	26	75	57
Brant County	21	67	2	2	10	43	5	5
Durham County	..	8	..	3	..	6	..	5
Essex County (80-100 miles)	100	100	14	.6	83	43	74	71
Frontenac County	1	5	0	.6	.2	3	5	5
Grenville County	..	.6	..	0	..	.1	..	5
Haldimand County	8	53	1	5	4	16	10	10
Halton County	..	10	..	2	..	7	..	4
Hastings "	2	19	0	7	.7	15	5	5
Huron "	21	33	5	6	11	14	5	5
Kent "	100	94	7	2	78	45	25	24
Lambton "	79	86	5	1	34	34	25	18
Leeds "	1	2	0	0	.2	.7	5	5
Lennox & Addington County	.2	5	0	.3	.4	2	5	5
Lincoln County	23	67	.3	7	5	29	15	15
Middlesex "	54	73	3	5	28	44	10	9
Norfolk "	17	55	.3	8	9	23	5	5
Northumberland County	2	20	0	2	.6	9	10	10
Ontario County	..	47	..	9	..	21	..	5
Oxford "	27	56	4	2	14	18	15	15
Peel "	..	10	..	.6	..	4	..	4
Prince Edward County (215 miles)	10	48	0	3	2	15	35	35
Welland County	64	100	.6	6	23	43	45	45
Wentworth County	3	89	.3	.3	2	22	5	5
York "	..	27	..	1	..	5	..	5

*NOTE: Mileage stated represents distance from Union Village, the original centre of the infestation. Welland County first found infested in 1920 and apparently a separate outbreak.

In addition to the above records, examinations were carried on in 1927 at points in the Counties of Carleton, Dundas, Prescott, Russell and Stormont which were known to be infested; but, as the three hundred stalks examined in the various fields did not show any infestation, these counties have been omitted in the preceding table. However, in several of the fields in these counties, with the exception of Prescott, infested stalks were found in carrying on a general examination, but were not encountered in the standard inspection.

As a summary of the preceding records it is pointed out that the degree of infestation at the points in circle No. 1 increased from 31 per cent. to 40 per cent. stalk infestation or 29 per cent. actual increase; Circle No. 2 increased about three per cent; Circle No. 3 decreased 11 per cent.; the single point in Brant county increased 330 per cent.; in Essex County there was a decrease of 49 per cent.; Haldimand County increased 300 per cent.; Hastings County increased at the single point by 2,000 per cent., although the average stalk infestation was only 15 per cent.; one point in Huron County shows an increase of 27 per cent.; Kent County has decreased 43 per cent.; Lambton County, at our five points, remained the same as last year although increases were noted in other parts of the county. In the Niagara peninsula a marked increase was noted in Lincoln County, the average stalk infestation at the three points examined being 29 per cent. as compared with 5 per cent. last year. Welland County increased also, at the rate of 86 per cent. and Wentworth County by 1,000 per cent. at the single observation point.

In regard to Middlesex County the records at our point in the northwestern section show an increase of 57 per cent.; but, considering the records of the concentric points in that county, as included in the summaries of Circles No. 2 and 3, the average stalk infestation is only 34 per cent. as compared with 33 for last year. At the five established points in Norfolk County the records for this year show an increase of 110 per cent., this year's average being 25 per cent. stalk infestation as compared with 11.8 per cent in 1926. Oxford County records at seven points show a decrease from 25.1 to 24.4 per cent. stalk infestation. In connection with the records in Prince Edward County it is interesting to note a further increase of the pest as records of 35 fields at the seven observation points show an increase in the average stalk infestation of from 2 to 15 per cent. or 650 per cent. actual increase.

A review of the 1927 situation, with those of the last four years in mind, indicates that the European corn borer will continue to spread to new districts and that in a great part of the territory, as yet lightly infested, it threatens to increase in abundance to a point where it will be of economic importance. Every indication points to the absolute necessity of a most careful application of control methods.

CAESAR—I presume that the figures given by Mr. Keenan are based solely upon the infestation records made by his inspectors and that no consideration was taken of the reduction in acreage of corn. If the latter is taken into account for Essex, Kent and Elgin he would estimate the decrease as greater than I have reported.

KEENAN—I might explain in this connection that these points were chosen five years ago and have been used each year. Our policy was to include only fields located within one-half mile of the point and this year at several of these there was not any corn and so records for these do not appear in the county or locality concerned.

ON THE OCCURRENCE OF APHODIUS PARDALIS LEC. AS A PEST OF LAWNS IN BRITISH COLUMBIA

W. DOWNES, DOMINION ENTOMOLOGICAL LABORATORY, VICTORIA, B. C.

In April, 1925, I received a complaint from the Powell River Pulp Company that numbers of small white grubs were seriously injuring the bowling green maintained by the company. A few of the grubs were received and were found to be larvae of a small scarab beetle. The mature larvae are about ten millimeters in length, when extended. It was at first thought that this was some species of *Anomala* and indeed the description of the injury gave color to that belief. The sod was said to be cut evenly about three fourths of an inch below the surface resulting in it turning brown and dying in large patches. Adults were reared from the larvae first received and the species was definitely identified by Mr. W. J. Brown, Coleopterist, Division of Systematic Entomology, Ottawa, as *Aphodius pardalis* Lec. In the spring of 1926 more of the grubs and a section of the sod stripped by them were received from Mr. Gretton, the gardener of the Powell River Company. The sod was, as before, cut off evenly a short distance below the surface and could be rolled up like a carpet. Adults were again reared from these larvae. In October a personal study was made of the situation at Powell River. The sod was taken up and the soil examined to the depth of eight inches. No young larvae

were found but a large number of adult females were collected from two to two and one-half inches below the surface. Although eggs were not found they were evidently present, for the sod, after being thoroughly examined indoors and all adults removed, was taken to Victoria and there placed in a soil box out of doors. In the following spring larvae were found to be present in considerable numbers and, at the end of April, these were half grown. Early in May a visit was paid to Powell River and the sod examined. Larvae of varying ages were found, the majority being nearly full grown, but some not more than two or three millimeters in length. In 1927 the injury appeared to be diminishing for not nearly so many larvae were present as in former years and no stripping of the turf occurred.

Aphodius pardalis is a very common species on the Pacific Coast. At Victoria, during warm days in September and October, the beetles are on the wing in great numbers and a long series can usually be obtained in a few minutes. The larvae are common at the roots of grass and I found many, in May of this year, under stones lying in moist grassy places. Pupation occurs in June and the adults emerge in July and August.

Although a common species on the Pacific Coast no previous case has ever been known of its causing damage to lawns and it is apparent that there must be some special reason for its destructiveness at Powell River. Powell River is a town of 4,000 people, the majority of whom are employees of the pulp company, one of the largest concerns of its kind on the coast. It is an isolated, out-of-the-way spot, about one hundred miles north of Vancouver, and the company has established a bowling green and golf course for the benefit of the residents. The surrounding country is hilly and at one time was covered with heavy bush which has since been logged off. Subsequent fires have reduced it to a wilderness of stumps, burning out what little soil there was and leaving only sand and gravel; this supports only a few weeds, with patches of stunted *Berberis* and *Gaultheria*. Wherever the soil is a little better a dense growth of alder has taken the place of the original bush. Except in moist pockets the soil is nowhere more than two or three inches deep and of a light sandy nature. Soil was brought from the neighboring hillside to make the golf course and bowling green and these two places, with the exception of a few small lawns in the town, are the only spots that would provide a breeding ground for *Aphodius*. During the years that trouble has been experienced from this species the seasons have been exceptionally dry, and as the larvae require a rather moist situation, the beetles would tend to concentrate on the well-watered golf greens and bowling green rather than on the drier fairways and hillsides. These conditions may possibly explain the unusual destructiveness of the beetles at Powell River.

Although several insecticides have been employed, a satisfactory method of control has not yet been obtained. As to means of control, we experimented this year with carbon bisulphide-soap emulsion as used with success in Connecticut, against *Anomala orientalis*. The results obtained were very poor, not more than 50 per cent. kill being obtained after an interval of four days, using a strength of 3 oz. of emulsion to 3 gallons of water. In addition, considerable burning occurred, due probably to the effect of hot sunshine the day following, but the grass recovered after a few days. The larvae were nearly all within one inch of the surface of the soil and varied in development from one quarter grown to nearly full grown. Probably better results could have been obtained earlier in the season with less likelihood of burning. Applications of Du Pont "Semesan" (Hydroxymercurichlorophenol) at the rate of 1 part to 400 parts of

water were also made in 1926, and the sod still smelt strongly of it in May, 1927, but the treatment appeared to have little effect upon mature larvae, as the majority were alive. The smell of phenol is, however, very persistent and it is suggested that liquid applications of this material in the fall might have a deterrent effect upon the adults.

THE HABITS OF THE ONION MAGGOT FLIES
(*Hylemyia antiqua* Meigen)

ALEX D. BAKER, M.SC., DEPARTMENT OF ENTOMOLOGY,
MACDONALD COLLEGE, QUE.

INTRODUCTION

The onion maggot may claim the doubtful honor of being one of the most important insect pests in Canada. It is to be found from coast to

Figure 1.—Section of an onion field where maggot infestation was very heavy. This field had been top-dressed with manure, plowed, and then harrowed, previous to the sowing of the crop.

coast in this country and is only too well known in the United States. The onion growers in the Province of Quebec find in it a continual source of worry and in some years very severe losses to seedling onions are reported. In other years the injury may be comparatively slight, but the grower who has once experienced losses from this source seldom feels safe thereafter.

Considerable attention, more particularly in late years, has been given to this pest both in Canada and the United States. The writer has been engaged in the study of this insect at Macdonald College for several years. It is in regard to one phase of that work, that given in the title of this paper, that he wishes to draw your attention. Sufficient attention has not been given to this phase in the past. This paper is intended solely in the nature of a summary of some of the work done along this line and in consequence experimental proof will be largely omitted.

Food Plants

It is the feeding of the larvae of the onion maggot that renders the insect injurious. In consequence the food habits of the insect at this stage are well known; but what of the food habits of the adult flies? To what extent can they obtain nourishment from the onion plant? Could they find sufficient food for their sustenance in a cleanly cultivated field of onions?

The onion maggot fly feeds on the onion plant to a very slight extent only, principally on small drops of moisture etc., adhering to the foliage. In cage experiments it was found impossible to keep the flies alive where they had access to healthy potted onion plants only. The flies died within a short time. The soil around the plants was kept damp, but while the water thus made available to the flies served to prolong life slightly, the flies very apparently required something more for their sustenance than that provided. Petri dishes containing water-saturated manure were tried but no marked lengthening of life was observed. By introducing sugar or molasses solution into the cages it was found that the flies fed readily, egg laying was induced and the flies were kept alive in captivity for considerable periods. However, under natural conditions, the latter materials are not normally available for the flies. On what, then, do they feed? A cleanly cultivated field of onions, in itself, will not supply the necessary food materials for the support of the onion flies for any appreciable length of time. This is more particularly true under dry weather conditions.

Flowering plants are sought by the onion maggot flies for food. The range of bloom they will visit is very large, but in general, the smaller flowers are those most frequently visited. This is generally true of most flower-visiting Diptera. However, of all the flowers visited the most sought after by the onion maggot flies is the common dandelion flower (*Taraxacum officinale*). This was first pointed out by the writer some three years ago and has since been confirmed by ample experimentation. Introduce a mixed bouquet of flowers into an experimental fly cage. If dandelion blooms are included in the bouquet the preference (?) of the flies is soon apparent. Outdoors the flies have frequently been observed feeding on these blooms in the vicinity of onion fields. At Macdonald College the most successful rearing of these flies has been accomplished by keeping cages supplied with fresh dandelion blooms. No other food was necessary and the flies laid freely when onion plants were introduced. To date we have no evidence, however, that the onion maggot breeds on the dandelion. Apparently this flower is a food plant for the adults alone. The writer has been able to formulate quite a strong case against the dandelion. Besides being the most important food plant of the onion-fly it is also visited by the flies of the cabbage maggot (*Hylemyia brassicae* Bouche), the beet leaf miner (*Pegomyia hyoscyami* Panzer), etc. The importance of trying to control the blooming of this weed thus becomes obvious.

Index to Time of Emergence of Broods

In Canada there are two full generations of these flies every year and at least a partial third. From the standpoint of the onion grower the most important generation is the first. This is the generation that does by far the greater damage. The dates of emergence of the various broods vary from one year to another, depending largely on weather conditions. Further, one brood overlaps another. The time of emergence of the first brood, and, to a lesser degree, the second brood are of considerable interest to the onion grower. Calendar dates are not reliable. If the flies appear on May 15th this year it does not necessarily mean that they will appear

on that date next year. They may appear on the 1st or again not until the 20th. Our most efficent control measures are directed against the flies and eggs. It is essential, therefore, that we know, at least, when the flies are likely to emerge and egg laying commences. Direct observation in the onion field should reveal the eggs but the flies may have been active for some time before the eggs are noticed. They have a pre-oviposition period of from 10 to 14 days.

In the control of insects in our orchards we are no longer governed to any great extent by calendar dates. We take the stage of growth of the tree, i.e. the food plant, as an index. Our sprays have been given names according to the stage of seasonal development the tree has reached at the time they are applied. Hence such names as "Pink Spray", "Green Tip Spray", "Calyx Spray", etc. The stage of growth of the food plant of an

Figure 2.—A parallel section of that shown in Figure 1, of the same field. Maggot infestation was very light. The soil had received essentially the same treatment as that shown in Figure 1, but (owing to lack of time), had not been plowed. As a result the added organic matter was left in the upper layers of the soil.

insect is a more reliable index of the development of that insect than a calendar date. On an average, physiological activity in plants and reproductive activity in animals begin at approximately the same point. Merriman let 6 degrees C (or 43 degrees F) represent this point which he took as a basis for his laws of temperature control of the geographic distribution of animals and plants.

Not only is the dandelion a favored flower of the onion flies but the succeeding crops of dandelion flowers are roughly co-incident with the occurrence of at least the first two broods of flies. When the dandelions are in bloom the flies are out. The dandelion's flowering periods are particularly well adapted to the needs of the flies. In the spring of the year start your control measures when the dandelion flowers appear. You are

more likely to have your baits, etc., in the onion field at the right time. While this rule cannot necessarily be a rigid one it should be found better than using the calendar as a guide.

Reactions to Storms

Where do the flies go on wet days? In seeking an answer to this question some interesting points arose. I think the majority of us imagine or presume that most insects "hide" in wet weather, under foliage, in crevices, under rubbish, etc. There is no doubt that a great many insects do this. Accordingly the writer spent some time making inspections of sheltering foliage, etc., in wet weather. Under leaves was thought to be a likely place, but results there were practically negative. Water tends to gather under small objects of this kind and the flies would stand a good chance of becoming submerged if they sought this shelter.

Try to "wet" an onion-maggot fly with water. It will be found quite difficult. Put the flies in a phial of water and shake them. The water rolls off them as it would off the proverbial duck's back. Water is not very injurious to these flies in itself, so long as it is free to run off the insect's body. In the spring it was quite a common sight to see these flies perched motionless *on top* of the dandelion flowers. In such a position the chances of submersion are small. The flower acts like a gridiron and carried the water off from under the fly. The flies' object is apparently that of finding a well-drained resting ground wherever it can. In addition, of course, completely sheltered situations are undoubtedly sought by the flies, particularly during heavy driving rains.

Chemotropic Responses

Touch a fly with oil and see how quickly it "takes" on its body. Cedar oil is particularly effective and the fly dies shortly afterwards. The body of the fly takes the oil up like a piece of blotting paper. Generally speaking, oils tend to act as repellents to the flies. Cedar oil on the onion plant would very likely prove an effective protector of the onion, but unfortunately it kills the plant. Paint the stem of a healthy onion plant with a camel's hair brush dipped in cedar oil. The plant will have fallen over at the treated point by the next day or thereabouts. This is unfortunate because the oil is effective against the eggs as well.

Oils used in baits usually act as repellents, at least they do not attract. Flint and Compton in Illinois claim satisfactory results from the use of a Bordeaux oil emulsion spray. In view of the above this mixture seems a very reasonable one and is one that the writer tried out this year at Mr. McEvoy's truck garden at Rosemount.

The activity of the flies is greatest on bright, warm days. During such weather they are attracted to moisture. Molasses and other sweetish substances appear to add to the attractiveness of the water. Such knowledge has been made use of in various poisoned baits. We endeavor to attract the flies with some favorable bait, to which we have added a poison that will not diminish the attractiveness too much. Considerable work has been done at Macdonald College to determine the chemotropic responses of the flies and find the most suitable lethal agent. These results will be published shortly.

Types of Soil Where Infestations Are Most Abundant

In conversation with onion growers the writer was impressed by the frequency of the remarks made by them in reference to an apparent pre-

ference of the onion maggot for certain fields or parts of fields of their farms. Certain areas were said to be "bad" for maggots. In another field a short distance off maggot trouble might be reported as negligible. In addition it was noted that infestations were very often "patchy", and on consulting the grower one is often told that the "pattern" of infested areas, so far as he remembered, was frequently the same in successive years. The thought therefore suggested itself to the writer that the adult flies have a certain preference in the selection of soils for oviposition.

The season of 1924 was a comparatively light one as far as maggot infestation of onions was concerned, but satisfactory conditions (from an entomological standpoint) existed on the farm of Mr. McEvoy at Rosemount, Montreal. In the taking of soil samples, considerable care had to be observed that smut injury should not be mistaken for maggot injury.

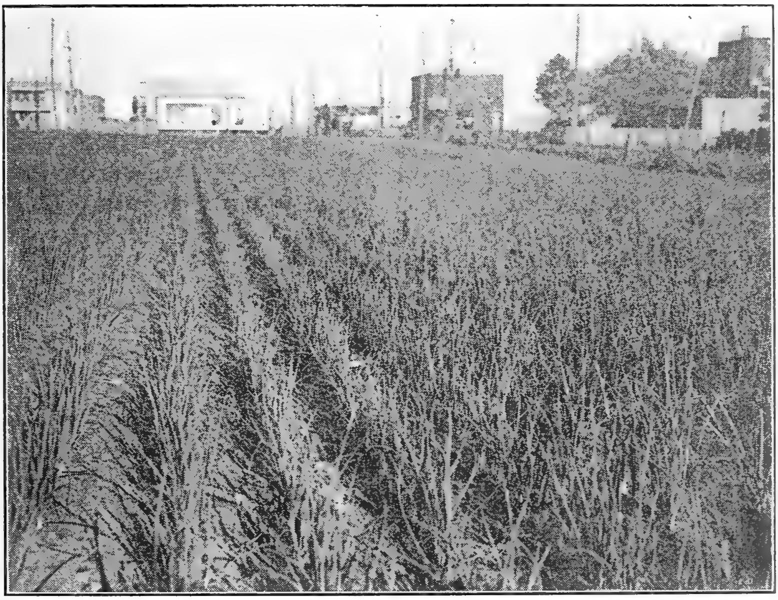


Figure 3—A field that has never shown any appreciable maggot injury although onions had been grown here for several years. Part of the same farm as the field shown in Figures 1 and 2. Showed a high percentage of combustible matter in the upper layers.

Smut was quite prevalent in some fields but where soil samples were taken, which were classed as infested types, care was taken to note the actual presence of the maggots so as to eliminate as far as possible any chance of confusion with smut injury. All samples were taken on the same afternoon, i.e., July 23, 1924. As the attracting or repelling principle (if any) would be located in the upper layers of the soil, the samples were not taken from a depth below four inches. The majority of the maggots would also be found above this depth normally. A physical analysis of all samples, both infested and uninfested, was made according to the method outlined in Chapter VI in "Soils" by Lyon, Fippin and Buckman. The various separates were named according to the U.S. Bureau of Soils classification.

The average percentage of sand, silt and clay for infested and uninfested soils were as follows:

	Uninfested	*Infested*
Sand	76.671%	79.017%
Silt	16.296%	13.835%
Clay	7.024%	7.145%

From the above the writer concluded that as yet we are unjustified in supposing that any predominance in any one separate or group of separates, such as would occur in fields suitable for the growth of onions, would be an important factor in rendering a field more dangerous from possible onion maggot infestation. Figures for the finer sand separates were also obtained from several representative samples. The results were such that the writer did not feel warranted in carrying the other soil samples further through the somewhat tedious process.

Tests to determine the degree of acidity of uninfested and infested soils gave the following averages:

Average pH for uninfested soils	6.8
Average pH for infested soils	6.825

When the orginal samples were tested for the percentage of combustible matter some interesting results were obtained. The average percentages for infested and uninfested soils were as follows: Uninfested, 12.09%; infested, 8.07%.

Of the samples taken no uninfested soil had a percentage of combustible matter as low as the average for infested soils and no infested soil had a percentage as high as the average for uninfested soils.

During the summers of the following years soil samples from other localities were taken as time and opportunity permitted and tested for percentage of combustible matter. In a few instances the earlier findings did not hold true. Briefly, it would appear that the different degrees in infestation which are very frequently found between fields having a high, as opposed to a low, percentage of combustible matter in the upper layers, is due, not so much to an attractive principle to the flies for oviposition but rather to conditions being more suitable for the development of their natural enemies in some soils than others. I refer particularly to the staphylinid parasite and predator *Baryodma ontarionis* Casey.

Other Responses

It has been frequently suggested that the onion maggot fly feeds on manure. It is true that they are very often to be seen in the vicinity of manure piles, particularly in the spring. It is noteworthy that this phenomenon is most noticeable on cool spring days. The response is most probably a thermotropic rather than a chemotropic one. As already pointed out these flies can not be successfully raised on a manure diet. In fact caged flies are not markedly attracted to manure. In such cases as did occur attraction was more probably a hydrotropic response.

The onion flies seek moisture on warm days wherever it may be found, on the onion plant itself, from the soil, from manure or open puddles. Undoubtedly some food material must be taken into the insect's body in solution during these activities but not in sufficient quantities to meet body requirements, nor of such a quality or quantity as to induce egg laying.

The positive heliotropic response of the flies, as is pretty well known, is very marked. After dusk, activity practically ceases. The brighter the

day, the greater the activity. Light of low intensity has but little effect. Bright sunshine and warmth induce the greatest activity. Under such conditions moisture attracts the flies readily. Light, warmth, and moisture would appear to be the three most important stimuli during a considerable proportion of the life of the flies.

DUSTAN—I would like to ask Mr. Baker if he has not found infestations lighter in clay soils than in sandy soils in St. Anne district?

BAKER—The infestations were usually heavier in sandy soils; where you would not find a high percentage of combustible material. The onion maggot lays its eggs where it finds the onion without reference to the kind of soil. Conditions for the development of the maggots are more favorable in one soil than the other.

ANDERSON—Have you been dealing with field sown onion or those transplanted?

BAKER—Practically all fields are sown and later thinned.

THE CANADIAN INSECT PEST SURVEY

C. R. TWINN, ENTOMOLOGICAL BRANCH, OTTAWA

The study of economic entomology in Canada is a comparatively recent one, and there are few authentic records of insect occurrence dating back more than seventy years. One of the earliest Canadian publications containing such records is "The Canadian Naturalist and Geologist," the first volume of which appeared in 1856. This was followed by "Le Naturaliste Canadien" in 1868, the "Canadian Entomologist" in 1869 and the first annual report of the "Entomological Society of Ontario" in 1870. In more recent times many other Canadian publications containing articles on entomology have appeared, but the data obtainable from these various sources, although valuable is, however, largely scattered and, during the past, in order to secure accurate and complete information on any one species it has been necessary to search laboriously through a great deal of literature. In a considerable number of cases, too, these data are lamentably incomplete as entomological workers have been few in number and the territory involved extremely large, consisting, as it does, of nearly three and three-quarter million square miles, embracing widely varying conditions in environment, topography and climate. In order to successfully promote the war against our numerous insect enemies, it is essential that we have as complete information as possible concerning their distribution, food preferences, seasonal abundance, etc., arranged in a readily accessible form.

With the object in view of supplying this service, the Canadian Insect Pest Survey was first organized in the autumn of 1922, under the direction of the late Mr. R. C. Treherne.* The aim of this survey is to provide a complete, accurate and growing record of the occurrence, distribution, seasonal prevalence, food habits and natural enemies of our economic insect fauna, and to assemble together current entomological data throughout the Dominion, in order to make it immediately available to workers in the field, so that they may be kept adequately posted as to entomological developments outside of their own circumscribed areas, thus developing unity and continuity to their individual efforts.

As the data accumulated by the survey improve in quality and quantity it may eventually become possible, by correlating these data with a study

*Obit., June 7, 1924.

of the conditions governing insect abundance, to forecast outbreaks of certain species with some degree of accuracy. Entomological forecasting is already being done in a modest way by field officers familiar with local conditions, but more ambitious aims are precluded from realization for some time to come, owing to the comparatively small number of entomological workers engaged, the vastness of the field in which they work, and the large number of species involved which claim their attention.

The Insect Pest Survey may be conveniently discussed under two headings, namely, the Insect Pest Record and the Insect Pest Review. The Insect Pest Record is a card index system consisting of 5" x 8" cards on which are typed all available data of the kind enumerated above, culled from publications, reports, correspondence, etc. These cards are filed alphabetically under the specific name of the insect concerned and bear the date and reference to the authority and source from which the information was secured. Under each species a card is also filed containing a list of the various predacious and parasitic insects reported attacking that species, and, in the case of animal and vegetable parasites and predators. reference is made to a separate file in which records of these latter are kept. At the present time, although the Record is far from complete, the majority of the reports and proceedings of our various entomological societies have been carefully reviewed and, in addition, many records added from our current survey work.

The Record has already proved very useful, consisting as it does of more than 10,000 records concerning over 2,000 injurious species of insects, but there is a great deal of work yet to be done, and its full value will only be realized when it is nearing completion. When brought up-to-date the Record will not only be of great practical value, but will also furnish a detailed historical record of each of the species comprising our extensive injurious insect fauna.

The Insect Pest Review is a mimeographed publication which has been issued from Ottawa at monthly intervals from April to October since the spring of 1923. The object of the Review is to keep entomological workers adequately informed of the current entomological situation throughout the Dominion and, as each volume is well indexed, to serve as a valuable record for future reference. Previous to 1923, there was no way in which entomologists could acquaint themselves with current entomological developments outside of their own limited region, except through the medium of correspondence, as published data do not usually appear until several months after the reported happenings have actually occurred. The Insect Pest Review by assembling data on current insect conditions from its collaboraters throughout the Dominion, is able to keep field workers adequately informed of the distribution, spread and seasonal fluctuations of well established pests and the introduction and spread of new ones.

In addition, thanks to the courtesy of Mr. J. A. Hyslop, of the United States Insect Pest Survey, Bureau of Entomology, Washington, D.C., a monthly summary of outstanding entomological features in the United States is also included, thus enabling our entomological workers to secure an adequate conception of insect conditions in the adjacent territories to the south. Another feature of the Review consists of monthly summaries of weather conditions throughout Canada compiled from data published by the Dominion Meteorological Service.

The five volumes of the Review already issued consists of 356 pages, each volume containing an average of more than 500 individual records concerning about 250 species of insects. Had it not been for the Insect Pest Review many of these records would probably have been lost sight of,

as in the ordinary course of events only a small proportion would have been published.

During the past, the entomological data published in the Review have been largely contributed by the field officers of the Entomological Branch working in the various provinces, but a few notes have also been received from provincial entomologists and certain members of the entomological teaching staffs of the provincial colleges and universities. It is hoped to develop this co-operative service more fully in the future, and in this connection, accurate observations on insects are welcomed from entomological workers and naturalists throughout Canada.

EFFECT OF CALCIUM ARSENATE ON FOREST TREES

A. Kelsall and J. P. Spittall, Dominion Entomological Laboratory, Annapolis Royal, N.S.

In view of the recent attempts to control insect pests on various trees by means of arsenicals and the probable further developments in this direction, it was decided, at the request of Dr. J. M. Swaine, Associate Dominion Entomologist, to try the effect of calcium arsenate both in spray and dust form on a number of different species of forest trees. While lead arsenate has generally been used with safety, it is more expensive and in some districts not so easily obtained as calcium arsenate. In controlling insect pests in forests it is inevitable that large amounts of material will have to be used, and if a material only a little cheaper than lead arsenate can be utilized it would result in a considerable saving. This experiment does not deal with pest control, but relates entirely to the tolerance of the respective trees to calcium arsenate.

The calcium arsenate used was a standard commercial material, widely and satisfactorily used on potatoes and, in conjunction with fungicides, in apple orchards. Several analyses of samples of this brand have shown it to be material of consistently good quality. In our experiment the calcium arsenate was used; (1) a series as a spray at the rate of one pound in forty gallons of water and (2) a series as an undiluted calcium arsenate dust. While most of the trees treated were in the same locality, some were several miles distant, but of course sufficiently near to be subject to the same climatic conditions. The tables below show the results obtained. Each tree was treated twice, except in the case of the white birch, where a different tree was used for the second application.

TABLE I.

Calcium arsenate 1 lb. in 40 gallons, applied June 6 and July 4.

Trees	Results on Inspection Dates— June 14	July 27
Spruce, white	No injury	No injury
Spruce, red	" "	" "
Beech	" "	Severe injury
Maple, white	" "	" "
Maple, rock	" "	Some injury. (May have been due to a fungus which was present on leaves).
Hemlock	" "	Slight injury
Fir	" "	Slight injury. (Fir not sprayed showed similar injury).
Pine, white	" "	No injury
Pine, Jack	" "	" "
Birch, yellow	" "	" "
Birch, white	" "	Slight injury
Elm	" "	" "
Poplar	" "	" "
Oak	Not inspected	Severe injury
Larch	No injury	No injury

TABLE II.

Calcium Arsenate 100 per cent. dust applied June 6 and July 4.

Trees	Results on Inspection Dates— June 14	July 27
Spruce, white	No injury	No injury
Spruce, red	" "	Slight injury
Beech	" "	Severe injury
Maple, white	" "	" "
Maple, rock	" "	Slight injury. (May have been due to a fungus which was present on foliage).
Hemlock	" "	Slight injury (doubtful).
Fir	" "	Slight injury. (Fir not sprayed showed similar injury).
Pine, white	" "	No injury.
Pine, Jack	" "	" "
Birch, yellow	" "	Slight injury where blast was heavy.
Birch, white	Severe injury	Slight injury.
Elm	No injury	" "
Poplar	" "	" "
Oak	Not inspected	Severe injury.
Larch	No injury	No injury.

From the above tables it will be seen that the only species of tree which suffered any injury from this material in the first application was the white birch (Table II), the calcium arsenate dust causing considerable burning of the foliage.

The weather following the first application was unusually dry, there being a total precipitation only of 0.55 inches between June 6 and July 4, when the second applications were made. Following the second application on July 4 to the date of inspection, July 27, there was a total rainfall of 4.76 inches, rain falling on no less than thirteen days. On the latter date eleven species of trees showed injury from the calcium arsenate dust and nine species were injured by the spray. The red spruce and yellow birch were uninjured by the spray, but suffered some injury from the dust. The only trees unaffected by the arsenical were white spruce, white and Jack pine, and larch. In view of the note with regard to firs untreated also showing injury, it is probable that the fir is also resistant to injury by this chemical. The fact that practically no injuries followed the first application and a considerable amount the second, may be accounted for in three ways. (1) That under dry conditions the trees were tolerant to this chemical. (2) That in the earlier stages of growth the young leaves were more resistant to arsenical injury than later in the season. (3) That foliage was capable of tolerating one application, but unable to withstand a second. Probably the injuries resulted from a combination of these three factors.

In conclusion, speaking generally, it is obvious that calcium arsenate may be safely used on soft wood trees, but that there are elements of danger in its use on hardwood trees, at least in moist climates.

THE EUROPEAN ROSE SAWFLY IN NEW BRUNSWICK*

R. P. GORHAM, ENTOMOLOGICAL LABORATORY, FREDERICTON, N.B.

During several years past the larvae of the sawfly, *Allantus cinctus* Linn., has been injurious to rose foliage in a New Brunswick greenhouse and has caused considerable loss. Two generations develop each year; one

*Contribution from the Division of Field Crop and Garden Insects, Entomological Branch, Department of Agriculture, Ottawa, Canada.

attacking the plants in March, April and May, the second in September, October and November. The larvae are only moderately abundant, but their habit of feeding on the youngest and most tender foliage near the top of the plant makes it difficult for the grower to cut blooms with good foliage attached.

The insect is supposed to have been first introduced in the egg stage on imported rose plants and proof of this has been secured in an examination of a recent importation of grafted rose plants received at the greenhouse with eggs in the leaves. Larvae were reared from these eggs. The insect has not been found on out-of-door roses in New Brunswick but numerous specimens of larvae have been found in shipments of field-grown roses imported from Europe and from these larvae, adults and parasites have been reared. The life-history in the greenhouse has been briefly studied.

The earliest adults begin to emerge early in March and deposit eggs at once. Other adults continue to emerge at intervals during April and the first part of May, with the result that the generation is extended over a considerable period; adults, eggs, larvae in all stages, including the pre-pupal, can be found in the latter part of April. The full generation begins early in September and continues until December.

Oviposition was observed first in April, 1925, when an adult reared from a branch in a glass tube on the 13th was moved to a caged rose plant on the 14th. Within an hour, this unmated fly began to deposit eggs. Alighting on the upper surface of a leaf in full sunlight in the laboratory window, the fly faced the centre with the claws of the posterior tarsi hooked over the margin. With this as a fixed point for leverage, the attachment of the legs to the body as fulcrum and the front tarsal claws grasping the leaf surface to apply force, the tip of the abdomen with its saw-like ovipositor was pushed downward and backward, cutting an incision 1.5 mm. long in the tough upper epidermis of the leaf. The fly then bent the body sideways and moved the saw about to enlarge the space beneath one side of the epidermal incision. On three occasions observed, the fly withdrew the saw before ovipositing, re-inserting it to reopen the incision; on seven occasions the egg was deposited at once, which may be considered the usual habit. Slightly less than two minutes was required, on an average, to cut the incision, form the pocket and place the egg in position. The movements of the saw and placing of the egg could be readily observed with a hand lens. The first fly observed deposited four eggs in one morning, six the next, and three on the third. Other flies observed in cages deposited from seven to thirteen eggs. Oviposition went on commonly during the morning hours of brightest sunlight. Eggs dissected out of the leaf were found to be pearl-white in color, without markings. These deposited on the 14th hatched on the 22nd, an incubation period of eight days. Later observations showed that this stage sometimes extended over twelve days.

The larvae, on hatching, cut through the under surface of the leaf, leaving a characteristic exit scar of slightly raised brown tissue with a crater-like hole in the centre. The young larvae feed at first on the underside of the leaf, biting out pieces of the parenchyma but not breaking the upper epidermis, which remains at first as a transparent, and later as a brown spot. The exit scars and first larval feeding scars disfigure the upper foliage of the plant and are particularly objectionable to the florist when he desires to cut sprays of bloom with good foliage. The second, third and fourth instar larvae feed on the leaf margins from

beneath, cutting out larger amounts of tissue but leaving clean edges and less noticeable disfigurement of the foliage.

When full-grown, the larva burrows in the pith of a rose branch, forming a small chamber closed at both ends with thin partitions of pith fragments. Sometimes two or more larvae enter the same branch and occupy chambers separated from one another by these thin partitions or plugs. Several months are passed within these chambers as larvae, the change to the pupal form taking place some two weeks before the emergence of the adults.

Summary of Life-history, Spring Generation

Adult emerged April 13.	
Eggs laid April 14; hatched April 22	8 days
1st larval instar April 22 to April 29	7 "
2nd larval instar April 29 to May 2	4 "
3rd larval instar May 2 to May 6	4 "
4th larval instar May 6 to May 10	4 "
Boring into branch May 10	
Prepupal period	? days
Pupal period	? "
Adult emerged October 12	
Total time interval	5 months, 2 days

In the early spring of 1926 the rose bushes in one house were pruned and the wood cut out shipped to the laboratory. The result was that from the prunings large numbers of adult sawflies were reared while the infestation in the rose house was so far reduced that the management decided no further control measures were necessary that season.

The dead twigs in which the larvae tunnel to pupate are commonly conspicuous and the pruning and burning of these with the contained larvae offers a simple control measure.

Certain rose plants appear to receive more eggs than others adjoining. Frequently one bush will be found in a row bearing many eggs while others have none. Three such bushes were marked and the leaves showing eggs, removed. At later visits these bushes were examined for larvae or signs of larval feeding. None were found, so it would appear that on small rose bushes where the upper leaves can be readily seen, picking the egg infested leaves as a method of control, can be practised by the careful greenhouse attendant in connection with his ordinary work of tying up and pruning the plants.

Greenhouse experience has shown that the larvae are readily killed by spraying the underside of the foliage with an arsenical spray. The stain left on the foliage by the drying sprays, however, is objectionable to the florist. Trial therefore was made of dusting the leaves with ground derris dust during different larval instars. It was found, that like other sawfly larvae, these were very susceptible to the toxic action of this material, and that they dropped in a helpless condition within two hours after application. No objectionable stains are left on the foliage or blooms.

In this infested greenhouse the management does not commonly use hydrocyanic acid gas fumigation but small scale experimental trials showed that both adults and larvae were readily killed by such fumigation, using the strengths commonly employed in the greenhouse.

THE GOLDEN-GLOW BORER

(*Epiblema carolinana* Walsingham)

R. W. THOMPSON, O.A.C., GUELPH

One of the borers very commonly mistaken for the European corn borer in Ontario is the one which attacks the golden-glow. Hence as the life history of this species (*Epiblema carolinana*) had not been worked out, Professor Caesar, at the suggestion of Mr. H. G. Crawford, asked me to undertake it. My study was carried out at Wyoming in Lambton County during the season 1927.

The Adult—This is a moth about the size of the codling moth (*Carpocapsa pomonella*) or slightly larger. The front wings are silvery gray and the hind ones brownish. (For a technical description see Forbes "Lepidoptera of New York and Neighboring States".) The first moth from collected pupae emerged on July 2nd. All pupae outside had transformed to moths by August 13th. The maximum emergence took place during the last week in July. Over 30 moths in all emerged from my material during the season. The moths are nocturnal, none being seen at anytime by day. They do not become active until at least one hour after sunset. They were not seen feeding upon any plant or substance outside but in cages took water.

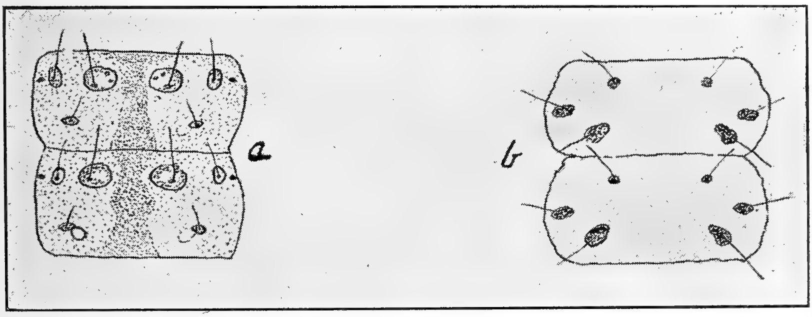


Figure 1 (a)—Third and fourth abdominal segments of *P. nubilalis*, dorsal view. Note the form and arrangement of these spots and also the presence of numerous fine chitinous dots. (b)—Same segments and same view of *E. carolinana*. Note the difference in arrangement and the smaller size of the spots, also the absence of the fine chitinous dots.

Egg-laying began (in cages) six to seven days after emergence. The eggs in nature are laid singly and are placed in the blossoms on the inside base of a bract. The highest number of eggs in cages from any one female was 45 and the lowest 17. The average oviposition period was six days; at the end of which time the female died. Thus the average length of life of a female moth was 12 to 13 days. Males lived a shorter period.

Eggs—These are a greasy opaque white, about 1.1 to 1.2 mm. in length and about .7 mm. at the widest end and .3 mm. at the other end. The general shape is somewhat that of a blunt tipped cone with rounded ends. Uneven granulations are quite conspicuous on the surface. The incubation period occupied from 4 to 5½ days.

Larvae—These pass through six instars. In all instars they resemble the European corn borer, but the third instar is the one in which the resemblance is greatest. At any time, however, the two species may be distinguished readily with a hand lens by examining the arrangement of

the spots on the dorsum (See fig. I). Another distinguishing characteristic is the arrangement of the curved apical hooks on the median abdominal pseudopods (See fig. 2). A full grown larvae of *E. carolinana* is two thirds of an inch long, creamy white, with brown head, and lighter yellowish brown thoracic shield. The body, as implied above, is sparsely dotted with small brown spots, these being smaller and more uniform in color than those of *Pyrausta nubilalis* (fig 1). The minute chitinised dots found on the skin of the dorsum of *P. nubilalis* are missing in *E. carolinana* (see fig. 1). In proportion to its length the golden-glow borer is stouter than the corn borer (see fig. 3).

Feeding Habits—It has been mentioned that the eggs are laid in the blossoms, not on the stalks as one might expect. On hatching, the larvae remain until their third instar in the blossoms, feeding beneath them in the receptacle and devouring almost all of this. Strangely enough, however, the blossoms remain intact so that the insect's presence would not be suspected. One has to pull the bloom apart and examine the receptacle to determine whether a larvae is present. In all the infested blossoms I examined there was only one larva to a head and apparently only one egg had been laid.

After reaching the third instar the larva leaves the flower head and drops by a silken thread to the ground. It then crawls back up the surface of the stem and eats its way in to it at an average height of four inches

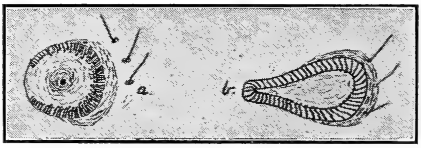


Figure 2 (a)—Arrangement of apical hooks on prolegs of *P. nubilalis.* (b) —Same of *E. carolinana.*

above the ground. Once inside the stem it works downwards until it reaches the root where the main feeding henceforth takes place.

In the root it gradually hollows out a large cavity often half an inch in diameter and six to seven inches long. Some larvae were found in the roots as low as eight inches below the surface. At the bottom of these root-burrows the larvae, judging from specimens examined Nov. 5 and 6, hibernate. No sign of a cocoon of any kind has been found. Before hibernating the larva, in some unknown manner, plugs the stem just below where it entered, and sometime afterwards the stem breaks off just above the plug. No exit holes were noticed at the above dates but it was seen during the summer that moths emerged through a hole made at the side, immediately below the plug. All unparasitized larvae are apparently full grown before hibernating. Parasitized larvae may be mature but are much stunted, being only two-thirds normal size.

Pupae—Pupation begins in late spring, or early summer, about the middle of June, the first one discovered in 1927 being on June 17th. The pupal stage lasts from seventeen to twenty days. Pupae are a chocolate brown, or in some cases a light reddish brown, and have a row of spines pointing caudad, around each segment. These spines are lacking in the corn borer pupae.

Effect Upon the Plant—As mentioned above, but little damage is done to the bloom, except that a very small bud, when attacked, has a distorted

flower head as a result. The injury from the attack on the root, so far as yet observed does not seem to be serious, perhaps because only the larger roots are infested and these have a large surplus store of food material which enables them to send up vigorous new growth in spring in spite of the borer. No plants other than golden-glow were found to be attacked during the season's observations.

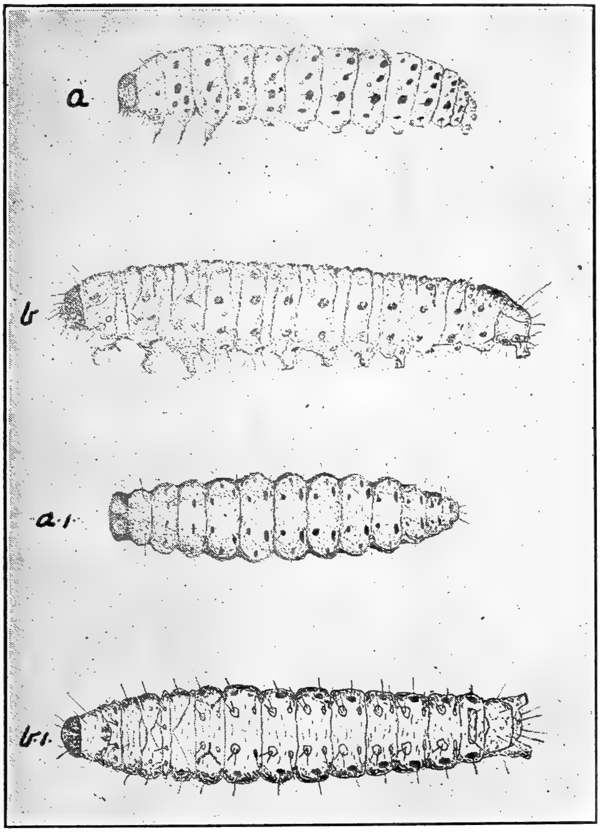


Figure 3 (a)—A lateral view of *E. carolinana*. a.1.—Dorsal view of same. (b)—Lateral view of *P. nubilalis*. b.1.—Dorsal view of same. All magnified about four times.

Amount of Infestation—It was found that the clumps of golden-glow which had been established for considerable time were the most heavily infested. In one clump 25% of the blooms were found to contain larvae, in others the infestation counts varied all the way from 2 to 25%.

Apart from the fact that this insect has an interesting life history it is really of very little economic importance up to date. It is heavily parasitized by an Ichneumon fly, belonging to the genus Bassus, which attacks the larvae in the earlier instars. From counts made this season it would appear that between 60 and 70% of the larvae were parasitized.

FORECASTING OUTBREAKS OF THE ARMY CUTWORM

(*Chorizagrotis auxiliaris* Grote)

H. L. SEAMANS, ENTOMOLOGICAL LABORATORY, LETHBRIDGE, ALTA.

INTRODUCTION

The army cutworm, *Chorizagrotis auxiliaris* Grote, is a spasmodic pest on the plains adjacent to the Rocky Mountains. From time to time it has caused serious losses in Alberta, Montana and Colorado, the larvae appearing in enormous numbers in spring and migrating from one field to another destroying everything before them. While moths and larvae are usually present every year the increase to outbreak numbers is sudden and seldom noticed until the larvae have appeared and are doing some damage. This is usually followed by a very heavy flight of moths which might be taken as an indication of an outbreak the following year but which seldom materializes.

A recent outbreak in southern Alberta started in a very small way in 1925. The following year the insect was distributed over some 500 townships with varying degrees of infestation. Fortunately the season of 1926 was very early and much of the land was not ready for seeding so that in the majority of cases the larvae were mature before any great damage resulted. During the season of 1927 the insect was found scattered over the same area and extending twice as far north though there had been a slight reduction in some sections. The use of poisoned bait and straight edged furrows across the line of march of the migrating larvae, as has been recommended for several years, reduced the losses to a minimum while a very wet season revived much of the grain that had been cut.

This outbreak has been studied with particular interest as it is the first one of any magnitude that has continued for two years in succession. Special attention has been paid to the ecology of all stages of the insect, in the hopes of determining some reason for the sudden increase and decrease from year to year. In very isolated cases, parasites and disease have been found sufficient to cause some fluctuation but these are not factors of control in the West to the extent that they might be under climatic conditions where outbreaks are liable to be frequent.

LIFE-HISTORY

The life-history of *Chorizagrotis auxiliaris* Grote, has been published in detail by Strickland (4)* and Prof. Cooley (1) based largely on the outbreak which occurred in 1915 in Alberta and Montana. The work of the last two years has added a few points which aid materially in determining the reasons for fluctuations.

Oviposition takes place in the fall some time after the third week in August, in some seasons extending well into October. The eggs are laid in soft, uncaked soil, irrespective of the presence or absence of vegetation. Incubation is rapid at a temperature of 55 degrees F. and is complete in ten days or two weeks. At the end of that time the eggs hatch if moisture is present but they may hold over for six weeks to two months if kept very dry. Under such conditions only a small percentage of eggs hatch and the larvae are small and weak.

Soil moisture in considerable quantities is essential to first instar larvae irrespective of the moisture content of their food. Ninety-six per cent. of

*Numbers in parenthesis refer to literature cited.

the first instar larvae died in the laboratory when kept at a humidity of 60 per cent. with fresh succulent dandelion for food. In nature they were found feeding on rotting straw, when green food was not available, gradually migrating to growing weeds and volunteer grain. After the first instar the larvae become less susceptible to drought conditions.

Freezing temperature halts all development until there has been a rise to 60 degrees F. when it is resumed again. Feeding stops when the temperature reaches the neighborhood of 45 degrees F. and the coming of prolonged cold weather causes the larvae to become inactive. There is apparently no real hibernation. The winter is spent in the loose soil at the surface of the ground where the larvae are to some extent subject to daily temperature changes. Activity is resumed during winter when the weather has become warm, depending on the length and degree of the cold snap to which the larvae have been exposed. During the season just passed (1927) the larvae recovered normally after a 48 hour exposure to a temperature of 10 degrees F.

Normal activity is resumed in the spring after the temperature has reached a point sufficient to start plant growth. The stage of development when activity is resumed, is entirely dependent on fall and winter conditions, a long warm fall followed by an open winter resulting in fifth and sixth instar larvae appearing in the spring.

Pupation takes place in an earthen cell two or three inches below the surface of the soil. In an average year the majority of the larvae have pupated by May 20 and the moths are usually beginning to emerge after the first week in June. None of the females contain developed ova on emergence.

The moths are very active and like the majority of this family fly mostly at night. While they are attracted to light they apparently do not fly long distances to it. Their presence around buildings is hardly due to light attraction but is apparently a matter of seeking places in which to hide; hundreds of them being found in barns, deserted buildings of all kinds, as well as in unlighted lofts of houses. In the fields they hide under clods, weeds and in any nook or cranny that will afford shelter during the day. It is probable that this is a temperature rather than a light reaction since they are active in daylight during cool weather and go into a period of aestivation when the season becomes hot.

The length of the aestivation period depends entirely on the seasonal temperature. During this time the moths are in hiding and large numbers have been found in the fields under clods and weeds practically dormant; others have been found in buildings but very few of these ever find their way out again. It is probable that the numbers which aestivate in the fields form the main source of ovipositing females in the fall.

As the weather cools, towards the latter part of August, activity is resumed, and the females contain fully developed ova. Oviposition starts almost at once and is carried on spasmodically during the fall when the temperature is between 55 and 70 degrees F.

Weather Data

A study of the weather records from twelve points scattered throughout southern Alberta for a total of sixty individual years, has given some very interesting results in connection with army cutworm outbreaks. In addition, several points in Montana and Colorado were studied where outbreaks have occurred in 1925 or 1926 for a total of forty years more. A "cutworm year" has been considered as starting on the first of June and extending to the last of May in the following year. Thus the study of

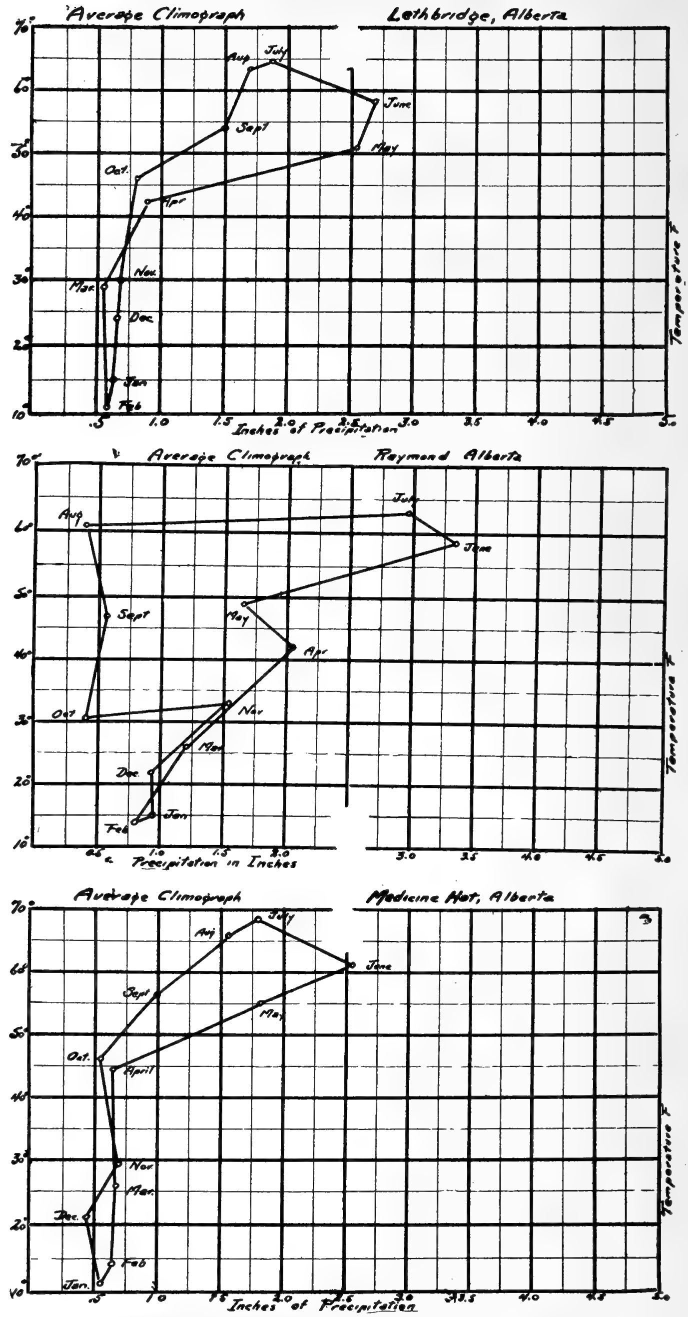


Figure 1.—Climographs showing average rainfall and temperature for Lethbridge, Raymond and Medicine Hat, Alberta.

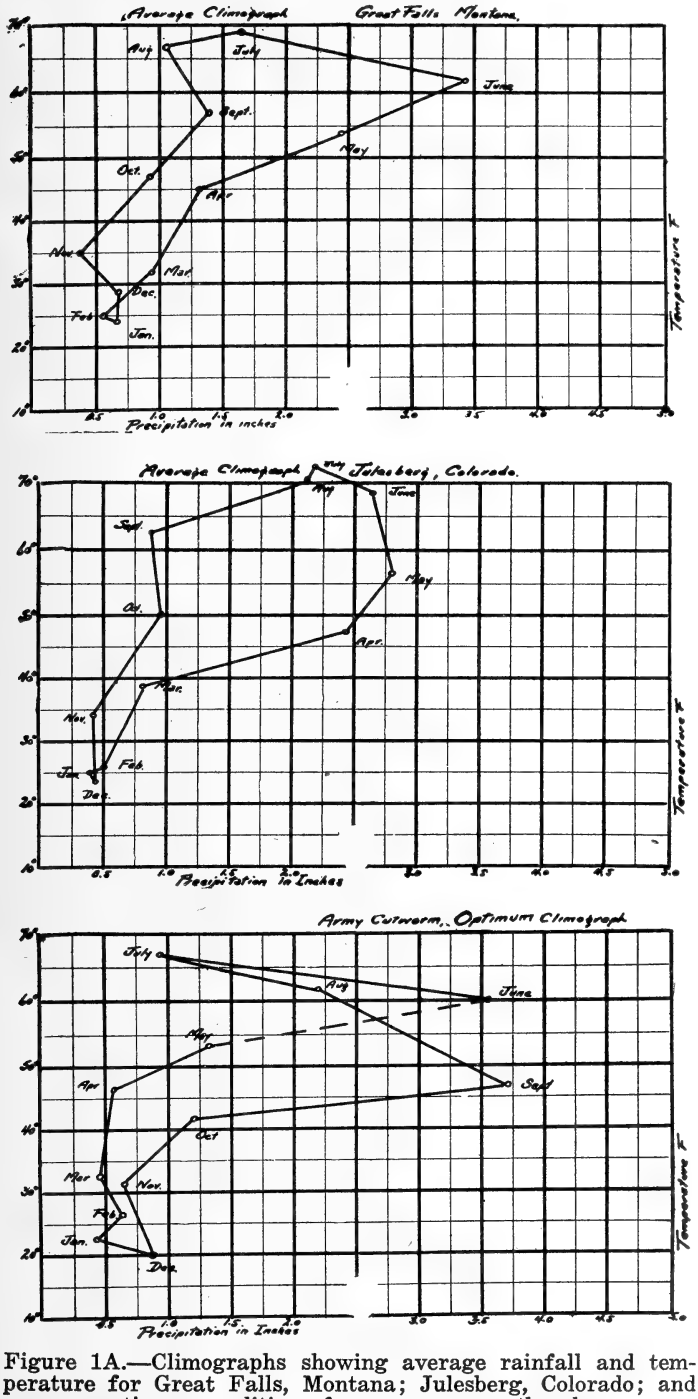


Figure 1A.—Climographs showing average rainfall and temperature for Great Falls, Montana; Julesberg, Colorado; and optimum conditions for armyworm outbreaks.

conditions governing an outbreak in the spring starts with the emergence of moths the previous June, since these moths are responsible for the infestation.

The weather conditions of thirty "cutworm years" covering outbreaks throughout Alberta, Montana and Colorado were studied and an average struck of the total precipitation for each month. This was plotted against the average mean monthly temperature as an optimum climograph for army cutworm outbreaks. When compared with climographs depicting the average weather conditions for all points throughout the same area the fact is apparent that outbreaks occur in the west only under very unusual weather conditions.

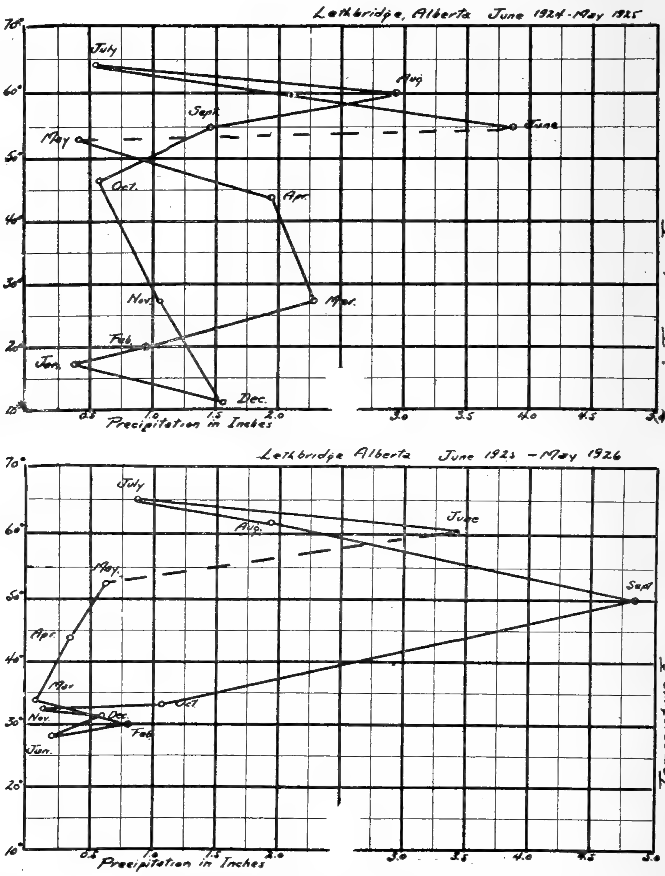


Figure 2.—Climographs for the Cutworm years 1924-5 and 1925-6 at Lethbridge, Alberta.

Only a few of the localities studied have been used for purposes of illustration, namely, Lethbridge, Raymond and Medicine Hat, Alberta; Great Falls, Montana; and Julesberg, Colorado. The climates of these points are more or less typical of the western plains where extensive outbreaks occur, and greatly resemble each other (Fig. 1). In the average year the three months period of May, June and July is the wettest period of the year while the three months of August, September and October are very dry. July is almost invariably the hottest month of the year but averages from one and three-quarters to three inches of moisture, depend-

ing on the locality, and is considerably wetter than any of the months of August, September or October.

The climograph for army cutworm showing the optimum conditions for outbreaks (Fig. 1) shows July not only as having the highest mean temperature but also as the driest month of the period from June to November. The difference in mean temperature between July and August, and August and September is greater than normal with the precipitation for each of the months of August, September and October greater than July. This is very unusual for the entire area studied and has only occurred three times in the last twenty-five years at Lethbridge. The rest of the months do not show any striking departure from the average and with the present

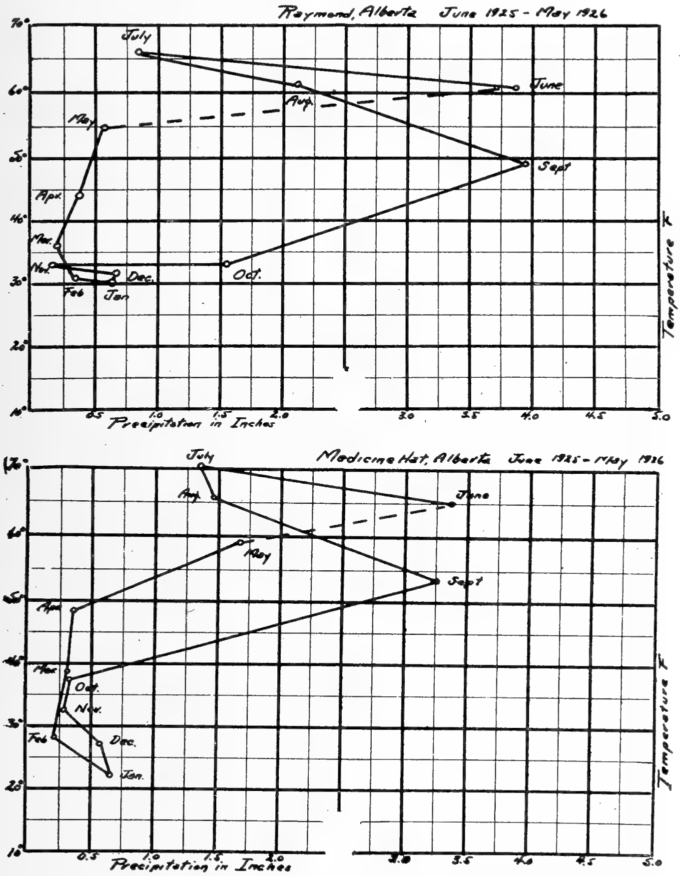


Figure 3.—1925-6 Climographs for Raymond and Medicine Hat, Alberta.

knowledge of the army cutworm are not considered as having any significance. It would appear then that the critical weather period governing the increase of the insect is from July through October.

A study of weather records for individual "cutworm years" in definite localities shows a yearly climograph closely approaching the optimum in spite of slight local variations. In the spring of 1925 there was a very small local increase of army cutworm near Lethbridge. This was not widespread enough to be considered an outbreak but indicated the presence of an increase factor. The climograph for the cutworm year starting with

June, 1924 (Fig. 2) shows a very dry July followed by an abnormally wet August. Both September and October are wetter than July but considerably drier than the optimum. In 1926 the increase reached outbreak proportions and the climograph for the cutworm year of 1925-26 practically coincides with the optimum. This same season the outbreak was heavier at Raymond than at Medicine Hat, a fact indicated in their respective climographs; Raymond having almost optimum conditions and Medicine Hat with a wet September but dry August and October (Fig. 3).

According to the State Entomologist's (3) report for 1925 there was an outbreak that year in Colorado covering a fairly large area. The report of the State Entomologist (2) for Montana indicated an outbreak in that state in 1926. A study of the weather records covering both outbreaks gives essentially the same results as are found in Alberta. This can best be illustrated by the climographs of Julesberg, Colorado and Great Falls, Montana, which are typical of the infested localities in both states (Fig. 4). Both show an abnormal weather condition approaching the optimum for army cutworm and the fact that in both cases August is drier than July does not necessarily detract from the value of August moisture but indicates a longer period of aestivation of the moths, increasing the value of September and October moisture.

Correlation of Weather Data and Field Observations

The moths are not attracted to light from great distances, but enough of them are caught in a light trap to serve as an index of the flights. According to the records at Lethbridge the second flight is much smaller than the first indicating a heavy mortality among the moths during the period of aestivation. Field observations have been made during July and August when the moth flight has ceased, to determine the status of the aestivating moths. In many instances moths have been found drowned in their hiding places after a heavy rain. Those hiding under clods of dirt are often found sealed in their hiding place by soil washed down from the clods during a heavy rain. Cooley (1) has also reported this as occurring in Montana. It would appear that heavy rains during the period of aestivation will be responsible for a considerable reduction in the females available for oviposition later in the season.

One of the outstanding differences between the optimum weather conditions and the average climate of the localities studied is the July rainfall. There is apparently a distinct correlation between the amount of July rainfall and the percentage of moths which survive for the second flight. This is best illustrated by a table made up of the light trap records of *C. auxiliaris* and the precipitation reports as follows:

Year	Per cent. of total moths caught during 2nd flight	July rainfall in inches
1914	29.50	.93
1915	.04	4.84
1921	.07	3.23
1925	19.77	.82
1926	6.63	1.15

These figures are not as complete as is desired since the light trap records were not kept between 1916 and 1921, the flights of army cut-

worm moths for 1922 and 1923 were too small to be significant and the light trap records were not kept after the first of September, 1924.

Since the length of the aestivation period is governed largely by temperature it is evident that in some localities where July and August are both hot and dry the low precipitation for both these months may be significant. Such a case is evident in the outbreak weather conditions for Medicine Hat, Great Falls and Julesberg as shown by their climographs (Figs. 3 and 4). In these particular cases the daily weather records show that the majority of the precipitation and the lower temperatures occurred after the middle of August and probably ended aestivation.

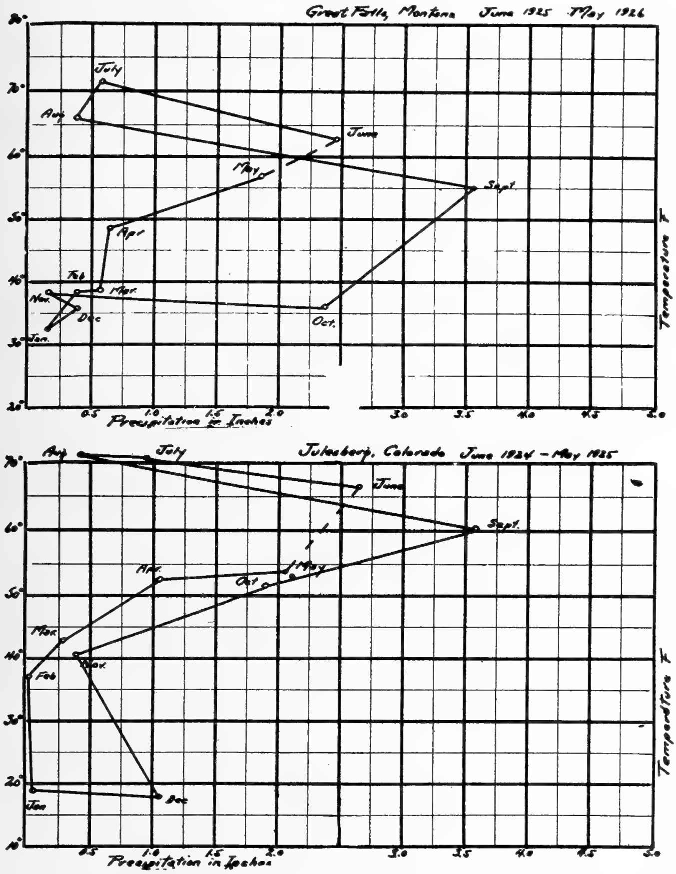


Figure 4.—Climographs of Great Falls, Montana and Julesberg, Colorado, covering the outbreak of the Army Cutworm in 1925 and 1926.

Field and laboratory investigations have proven that moisture is essential both for the hatching of eggs in quantity and the survival of first instar larvae. The optimum weather conditions for army cutworm include an excessive amount of moisture in September insuring a high percentage of hatching and the survival of the majority of the first instar larvae. August and October moisture may or may not be important depending on the length of the aestivation and oviposition periods. The 1924-25 climograph for Lethbridge (Fig. 3) has an ideal July for the moths but the August precipitation apparently did not occur at the right time for bring-

ing through the majority of eggs and young larvae while September and October were fairly dry. On the whole it was a better year than the average for increase but not near enough to the optimum for an extensive outbreak.

The importance of the total August, September and October rainfall in producing outbreaks is indicated by a table made up of the figures showing the percentage of moths surviving from the first flight, the total rainfall for the three months and the status of outbreak the following year. The per cent. of moths of this species caught in the second flight as compared to the total catch for the season, is considered as an index of the numbers surviving the period of aestivation.

Year	Per cent. of moths surviving	Total inches of rainfall Aug. Sept. Oct.	Outbreak Status
1914	29.50	6.83	Heavy
1915	.04	3.24	None
1921	.07	.24	None
1925	19.77	7.79	Very heavy
1926	6.63	7.24	Very heavy

Neither of the tables cover enough years or localities to be considered conclusive in themselves but they indicate a trend of increase and when combined with the climographs are significant in showing relationships.

Conclusions

From a study of the weather records covering outbreaks of the army cutworm in widely scattered localities in Alberta, Montana and Colorado it is evident that the outbreak is directly concerned with a weather condition which is so far from normal that it cannot be a common occurrence. It is possible that there are some sections of North America where the weather conditions would fit into the optimum more frequently and outbreaks be more common. In such localities a method of forecasting the outbreaks might have to take other factors than weather into consideration.

After studying the weather records for the western Great Plains area it has been found possible to forecast with considerable accuracy any increases in the army cutworm by keeping track of the rainfall and temperature from the first of July until the first of November. This was tried with one hundred yearly records and thirty local outbreaks recorded correctly.

The forecasting of outbreaks is based not only on the optimum climograph but on a study of the available weather records from which the optimum was made. These show that a July with less than one and one-half inches of rainfall and a mean temperature above 63 degrees F. is favorable to increase but does not mean an outbreak the following year. If the dry July is followed by a total of over four and one-half inches of precipitation during August, September and October, with the greater proportion of this coming in September, an outbreak is assured.

Acknowledgments

The working up of this data has only been made possible through the courtesy of the Dominion Meteorological Service in supplying the weather records for Alberta and through the kindness of Mr. W. T. Lathrop and Mr. J. M. Sherier, meteorologists at Helena, Montana and Denver, Col-

orado, respectively, who so kindly furnished the records wanted for those states.

Summary

The army cutworm *Chorizagrotis auxiliaris* Grote, is one of the pests of the western plains which suddenly appears in enormous numbers and is gone again in a year or two. The losses caused by this insect are largely due to the suddenness of its appearance and the lack of preparation for control measures.

A study of the western climate and yearly weather conditions indicates that optimum moisture and temperature for army cutworm increase is so far from the average climate that outbreaks cannot be frequent or of long duration. Field observations, when correlated with the optimum conditions show why certain weather features are important and why July, August, September and October are critical months in the life history of the insect.

Outbreaks of the army cutworm are apparently a result of a hot July with less than one and one-half inches of rainfall followed by a total precipitation for August, September and October of over four and one-half inches. This has been used as a basis of forecasting outbreaks with satisfactory results for over one hundred yearly records thirty of which included heavy infestations.

Literature Cited

1. Cooley, R. A.
1916.—Observations on the Life-History of the Army Cutworm (*Chorizagrotis auxiliaris*).
Jour. Agric. Res. 6: 811-881.

2. ————
1927.—Montana Insect Pests for 1925 and 1926.
Montana Agric. Exp. Sta. Bull. 200: 9-24.

3. Langford, G. S.
1926.—The Army Cutworm (*Chorizagrotis auxiliaris* Grote) in 1925.
Rep. State Ent. Colorado 17 (Circ. 51): 19-22.

4. Strickland, E. H.
1916—The Army Cutworm, *Euxoa (Chorizagrotis auxiliaris* Grote).
Dept. Agric. Canada, Bull. 13.

TWINN—I should like to ask Mr. Seamans what his forecast for 1928 is, based on the records for the present year.

SEAMANS—Based on the records for Alberta only, for 1927, we have had a July with over three inches of rain, but, we also have had August, September and October with just under four inches of rain. I look for a decided reduction—because our second moth flight was very small. We take into consideration the very cold July in which the moths never went into a real distinct aestivation period.

TWINN—It should be possible in future years to broadcast warnings of outbreaks to farmers over the radio.

SEAMANS—We do not have to work so close to the margin as that. We can forecast by the first of September. We have thus plenty of time before the cutworms appear, as the cutworms do not appear till the first of the following April.

THE LIFE OF PROFESSOR WILLIAM LOCHHEAD

REV. FATHER LEOPOLD, OKA, QUE.

As an intimate friend of the late William Lochhead, I have chosen to read you a paper on the life history of one whose work was in close relation with the Ontario Entomological Society and the Quebec Society for the Protection of Plants. I know that I will not do justice to my subject, but I have overlooked all that in the hope that I will try, at least, to show his friends that we have lost in his person, a devoted student and professor of biology in its broadest sense.

Professor Lochhead died at his home, in Ste. Anne de Bellevue on the 26th of March, 1927, after an extended illness, on account of heart trouble. His loss was deeply felt by us all in Quebec, as our Quebec Society for the Protection of Plants was convening the day after and his absence was shedding a sort of gloom all over our deliberations.

Professor Lochhead was one of the senior members of the original staff of the College and Faculty of Agriculture of McGill University, at Macdonald College. He had retired from active work in September, 1925 on account of his heart. He had a wide circle of friends, not only in the Provinces of Quebec and Ontario, which were the scenes of his life-work, but in the States and other Provinces, in scientific and educational circles.

He died in his sixty-third year, having been born in 1864. William Lochhead, the fourth son of William Lochhead, a well-known Scotch farmer, of Elma Township, County of Perth, Ont., spent his boyhood on the farm, where he became acquainted with the details of farm work. No doubt it is there that he acquired such a lasting love for nature that helped him out so much afterwards in his teaching atmosphere. He received his early education in the school at Elma, from which he passed into the Listowel High School, and in 1881 matriculated for McGill University, winning a general proficiency scholarship. At McGill, he won scholarship after scholarship, proving himself proficient in mathematics as well as science. While at McGill he came under the direct contact and influence of Sir Wm. Dawson, then professor of geology and zoology, and whatever success has attended his teaching efforts since his graduation, Professor Lochhead attributes to the splendid example shown by that grand old man. The careful training he received at the hands of such a man as the late Principal of McGill, maintained a life influence on the biology teacher that William Lochhead was to become soon. He left McGill with his B.A.

Like many young men with limited means and a strong desire to further the cause of science, he decided to follow the teaching profession. After a course of training in pedagogy, at the Kingston Training Institute, he secured his first position in the Perth Collegiate Institute; but resigned it six months later to accept a fellowship in Geology at Cornell University. He returned from Cornell to Perth and taught two years, after which he went to Galt, where he remained five years in charge of the Scientific Department of the Collegiate Institute. The years 1894 and 1895 saw him again at Cornell, devoting himself to biology and geology, working under the guidance of such inspiring teachers as Professor Comstock, Tarr, Atkinson and Gage. He learned their methods of work and the secrets of their great success as investigators and instructors. In 1895 Professor Lochhead secured the degree of Master of Science (M.Sc.) from Cornell University. He taught in Napanee during the following year but resigned in 1896 to accept the mastership of the London Collegiate Institute. From thence he becomes identified with most of the work in biology and geology at the O.A.C., Guelph—September, 1898.

I may say that, hereupon, Professor Lochhead enters a new page in his arduous life. Succeeding Professor J. H. Panton, after the latter's death, on the O.A.C. staff, the young teacher began his real career. The teaching of biology, geology and entomology fell then to one professor and when this is given to students in three years, one can appreciate the heavy task. On the appointment of Professor Lochhead, the task was divided and Mr. M. Doherty of Eglinton, Toronto, was named his assistant. "My O.A.C. days, writes Mr. Lochhead, although full of hard work, are a pleasant memory, and I enjoyed my work under Dr. Mills and Dr. Creelman, to both of whom I am deeply grateful for encouragement and aid. The boys were a fine lot, and many are now occupying high positions of responsibility and trust in Canada and elsewhere. One of the fine things is to meet these men and to swap stories of the old days. I am especially pleased to see my old friend and associate, Mr. Doherty at the head of the Department of Agriculture in Ontario, and my former pupil E. C. Drury, as premier."

Though eminently successful as a teacher, Prof. Lochhead was interested then as always in other matters outside his profession. At Guelph, the Educational Department honored him with the appointment of examiner in Methods in Science for the Normal College at Hamilton. He took a keen interest in the pursuit of scientific knowledge whenever the opportunity occurred to him, and the Ontario Entomological Society found in him a good worker and an enthusiastic collector of specimens.

From the foregoing it will be seen that William Lochhead enters upon the responsible duties connected with the Department of Entomology and Biology of Guelph with a practical and comprehensive training in natural sciences which eminently fit him for discharging those duties in a way that did result in great benefit to the college and to agriculture in general.

Professor Lochhead's stay at Guelph was the period of his development applied to entomology and the time of his earlier investigational work. Although his teaching then was very strenuous, he gave much of his time to investigations, particularly in relation to the San José scale and the Hessian fly. He did much to bring the results of his work in the domain of research to the farmers themselves by dint of field work and the study of practical methods of insect eradication. It need only be necessary to list the titles of the bulletins he wrote then, either alone or in collaboration to prove this:

The San José Scale and other Scale Insects, Ont. Dept. Agr. Spec. Bul.
Insects and Plant Diseases. Bulletin (special) Ont. Dept. Agr. Bul.
The Hessian Fly in Ontario. O.A.C. Bulletin, No. 116.
Spray Calendar, O.A.C. Bul. No. 122.
Peas and the Pea Weevil, O.A.C. Bul. No. 126.
The Weeds of Ontario, O.A.C. Bul. No. 128 (with Dr. F. C. Harrison).
The Present Condition of the San José Scale in Ontario, O.A.C. Bul. No. 133.
Outlines of Nature Study, O.A.C. Bul. No. 142.
The Common Fungous and Insect Pests of Growing Vegetable Crops, O.A.C. Bul. No. 150 (with Mr. T. D. Jarvis).

As you no doubt notice by the above enumeration, he was much interested in rural educational methods particularly regarding the advantages of introducing a study of Nature in the schools where farm boys and girls were being taught. Hence his bulletin on Nature Study. He was a passionate lover of nature and knew how to enthuse others.

I come now to the third period of the valuable educational work of Professor Lochhead, his stage at Macdonald College. In 1905 he was appointed Professor of Biology and acted as one of Dr. J. W. Robertson's chief advisers in the organization of that great institution, in whose service the

remainder of his life was spent. When the Department of Biology was divided in 1920, Professor Lochhead's title was altered to that of Professor of Entomology and Zoology. He was always devoted to his students—spared neither time nor energy for their biological training.

As an entomologist, he was President of the Ontario Entomological Society in 1902-4; a member of the American Society of Entomology of the American Nature Society of which he was vice-president in 1910; a Fellow of the American Association for the Advancement of Science and of the Canadian Society of Technical Agriculturists.

In addition to his investigational and educational work at Macdonald, Prof. Lochhead's services to agriculture included twelve years editorship of the monthly Journal of Agriculture and Horticulture of the Quebec Department of Agriculture, 1908-20. One of his last services to Macdonald College was a mission to the public schools of the United Kingdom to present to boys the opportunities open to them in agriculture in Canada. This was in the winter of 1923-24.

During this stage of his life he wrote his most complete work, his Class Book of Economic Entomology, 1919, which is the college text book followed at Macdonald today, and later on, an Introduction to Heredity and Genetics, 1920. I need not dwell upon the merits of such publications.

But to me, personally, the outstanding work of Professor Lochhead's career at Macdonald was the foundation and carrying on of our Quebec Society for the Protection of Plants from Insects and Fungous Diseases. The society was created through his energetic efforts and he was the living lever that maintained it so long on such a high plane. I have only to look at the long list of addresses and papers *(see foot note attached)* he prepared as president of our society to show you that we are fully indebted to him for the upkeep of such an association. It was due to his untiring efforts that we can boast, with the Ontario Entomological Society, of having a series of valuable reports to offer to the scientific world today.

1908-09—Spoke on diseases only: The Brown Tail Moth.
1909-10—Spoke on diseases: The Greenhouse Aphids.
1910-11—Adaptations between plants and insects, diseases; Lochhead and Swaine: Spray Calendar.
1911-12—Three pests: The Brown Tail Moth. Bees, friends of the agriculturist. Insect pests of the farm-garden and orchard; weeds.
1912-13—Parasites as means of combating noxious insects. History of parasitism. The destruction of the Gypsy Moth by parasites: *Anastatus bifasciatus* as egg parasite; *Schedius kuvanae,* also *Compsilura concinnata,* parasite of the larvae, *Blepharipa scutellata; Monodontomerus aerus,* of the pupa; *Calosoma sycophanta.* The destruction of the Brown Tail Moth: *Pteromalus egregius, Apanteles lacteicolor; Meteorus versicolor; Zygobothria nidicola; Dexodes nigripes; Pales favida; Monodontemerus aereus and Pimpla instigator.* This paper was a very important one and bears 12 pages of text with numerous illustrations.
1913-14—Insects and diseases of the season: Easy means to recognize good and noxious insects.
1914-15—Life-Span; Nature's equilibrium, organic and inorganic matter, insects and plants; insects and diseases; insects and birds; parasitic insects; life-span—seven pages. Principal noxious insects of the season. Insects attacking ornamental trees, greenhouse pests, domestic animals and houses. How to recognize some important insect pests: A table for *Shingidae, Tabanidae, Trypetidae, Cerambycidae, Curculionidae, Sclitidae, Blattidae, Acrididae, Locustidae, Bryllidae.*

1915-16—Some aspects of insect life: Instinct of insects; insects and the weather; insecticides—twelve pages. Insects of Quebec cereal crops. The Hessian Fly, etc.

1916-17—Presidential address: A review of some of the publications appeared in the entomological domain: The Rocky Mountain Grasshopper by Riley, Packard and Thomas; The Gypsy Moth by Forbush and Fernald; the Cotton Boll Weevil of Mexico by Hunter and Pierce; the Periodical Cicada by C. L. Marlatt and the Spring Aphis of Grains. Then follows a review of other minor publications, the list being too long to mention here. Near relations of insects that are noxious to plants and animals. That is other classes of *Arthropoda crustaceans*, etc.

1917-18—This year the presidential address of Prof. Lochhead was an elaborate synopsis of the first 18 years of the history of the Society for the Protection of Plants against Insects and Fungous Diseases. He outlines in a masterful way the three objects of the Society:

1. Bring together each year all the biologists of the province and surrounding provinces who are in any way interested in the study of entomology and phytopathology, as our Quebec society embraces both of these characters.
2. Expand among the people the broad gospel of economic entomology and phytopathology.
3. Promulgate further the study of insects and plant diseases by its publications, reports and special lists prepared now and then such as *Lepidoptera*, by Winn; *Diptera* by Beaulieu and Winn and *Coleoptera* by Chagnon.

It would be too long to fully report on this remarkable paper, covering 5 pages of the annual report.

How our Society can help production?

1918-19—How to make a study of economic entomology. In his presidential address Prof. Lochhead tells us how to rear insects and goes fully into details of cages, etc. He then tells us how to raise parasites. Around the farm is a title of another paper he delivered that year, in which his love of nature is shown very profound. Speaking to the boys and girls of the County of Brome, he tried to inculcate into their young souls some of that love for the beautiful country around them, for the study of insects and flowers, etc.

1919-20—His presidential address this year was on the natural control of insects, which he studies under four heads: 1, Climate; 2, Feeding; 3, Predacious Animals and 4, Animal and Plant Parasites—13 pages. Later on he repeated before our society his address given before the Ontario Entomological Society a few weeks previous: An important bioclimatic law, Hopkins.

1920-21—At this date our president made a very good synopsis of the story of spraying mixtures and reviews:

1. The use of Paris Green against biting insects; 1860-70.
2. The introduction of Bordeaux mixture as a fungicide; 1885.
3. The introduction of Lime Sulphur, first as a contact insecticide and later as a fungicide in 1906.
4. The use of lead arsenate and calcium arsenate as insecticides against biting insects.
5. The use of kerosene emulsion and tobacco extracts as contact insecticides.
6. The practicability of combining the more important insecticides and fungicides for spraying.

7. The manufacture of spray materials in the powdered form and the introduction of dusting.
8. A better knowledge of the chemical reactions that occur when different spray materials are brought together and the physiological action when these mixtures are brought together.
9. A better knowledge of the life history and fungi, to make a better use of the spray calendars.
10. Closely connected with the developments of spraying is the development of spraying outfits, which he only mentions and does not discuss.

1921-22—As this year we had as our guests two eminent professors of Toronto in the person of Dr. C. D. Howe and Dr. J. H. Faull, it was very fitting that our president give in his address a forestry paper: The Pioneers of Forestry Entomology. He emphasizes the life of Ratzeburg of Berlin on one side and a host of others who studied parasitic insect life such as: Boisgiraud of Poitiers; Antonio Villa and Rondani, two Italians; Perris of France and also Decaux; among the Germans: E. L. Taschenberg, G. Henschel and J. H. Kaltenbach. Professor Lochhead pays a tribute to such forest entomogolists as Packard, Dr. Felt and Dr. Swaine, with Dr. Hopkins.
With the help of Mr. Tawse of the horticultural department, Macdonald College, Professor Lochhead began that year experimental work in the onion truck gardens to determine the best methods to control the onion maggot.

1922-23—As the Quebec Society for the Protection of Plants held a joint meeting with the Canadian Phytopathological Society Professor Lochhead spoke on the protection of plants in general, rather than in a particular viewpoint.

1923-24—His health failing, a leave of absence was accorded him, and I had to take the chair as vice-president of our Society at the annual meeting in 1924.

1924-25—Again occupying the presidential chair on account of Professor Lochhead, we inserted in the annual report a lengthy paper prepared by him on applied entomology in Russia.
That was the last report we were to read in our annual reports by our sympathetic president as he resigned the presidency after having held the chair since the very foundation of the Society.

In looking back over the long period of educational work of such a man, I think that a further development can be noticed in the past 15 years of his life. His work was concerned with even something more than teaching and investigation. Finding out facts of science and imparting facts to students were not sufficient in themselves. I believe he saw something more in his work, which for want of a better word, I may call it the Humanity of Science. He was, I may say, a man extremely free from prejudice and had a intense sympathy for his fellow man and particularly for the tiller of the soil, a feeling due partly, no doubt, to his earlier home experiences with his family who cleared the land in the early days of settlement in Perth County.

The cold facts of science were not enough for him. They were only means to make life on the farm better for his province and country and for this reason he was so much wrapped up in our Quebec Society for the Protection of Plants.

Yet he remained a teacher, I think, through and through, due to his breadth of outlook. You can hear today more than one of his former stu-

dents tell this. He had a certain ability to make the student think. He was an excellent teacher and speaker. He has the distinction of being one of the very few outstanding professors, to my mind, of whom his students say: "He made me think. He woke me up. He discovered me to myself." I know that I have often been inspired in my humble and personal work at Oka by his unceasing labor and good will. This will be for me the best souvenir I can keep of such a noble life.

Following is a list of the addresses and papers published by Professor Lochhead in the Annual Reports of the Quebec Society for the Protection of Plants:

1908-09—Diseases of Plants
Fungous Diseases in Quebec, 1908
Three Important Fungous Diseases of the Orchard
The Best Fungicides
Some Fungous Diseases of the Garden
The Brown-tail Moth

1909-10—Four Common Fungous Diseases of the Garden
A Stem Rot Disease of Potatoes
Some Fungous Diseases of the Greenhouse
The Crown Gall of Fruit Trees
Some Noxious Weeds of Quebec
Scale Insects in Greenhouses

1910-11—Weeds
Adaptations Between Plants and Insects
Fungous Diseases in Quebec in 1910
Some Fungous Diseases of Field Crops
Why Certain Plant Diseases Persist
Spray Calendar (with J. M. Swaine)

1911-12—Three Pests Threatening Quebec
Apple Tree Cankers
Bees as Friends of the Agriculturist
Insects Injurious to Farm, Garden and Orchard Crops
A Study of the Paint Brush or Orange Hawkweed

1912-13—Parasitic Insects in the Control of Injurious Forms
Concerning Cutworms, Wireworms and White Grubs

1913-14—Insects and Disease
Useful Keys to Some Important Economic Insects

1914-15—The Web of Life
Principal Injurious Insects of the Season 1914
Insects Affecting Shade Trees, Greenhouse Plants, Domestic Animals and the Household
Useful Keys to Some Economic Families of Insects

1915-16—Some Aspects of Insect Behavior
Insect Pests of Cereal Crops of Quebec

1916-17—Masterpieces of American Economic Entomology
Near Relatives of Insects Injurious to Plants and Animals

1917-18—The Protection of Plants
The Most Common Plant Lice or Aphids

1918-19—Methods of Studying Economic Insects
Some Common Things on the Farm

1919-20—The Natural Control of Insects
The European Corn Borer
An Important Bioclimatic Law

1920-21—The Story of Spraying Mixtures

1921-22—Some Early Forest Entomologists
Experiments on the Control of the Onion Maggot, 1921 (with W. J. Tawse)

1922-23—The Protection of Plants

1924-25—Applied Entomology in Russia

THE ENTOMOLOGICAL RECORD, 1927

NORMAN CRIDDLE, ENTOMOLOGICAL BRANCH, DOMINION DEPARTMENT OF AGRICULTURE

The present "Entomological Record" follows closely along the lines adapted in former issues. We regret, however, that lack of time has prevented the preparation and incorporation of complete lists of certain families such as were provided on previous occasions. There has also been a falling off in the number of records received from amateur collectors and as a result of these combined deficiencies the present "Record" is considerably shorter than usual.

Few outstanding publications of interest to Canadians have been issued during the year but of those worthy of note the following may be mentioned.

Butterflies of California, by John A. Comstock, 334 pp., 63 colored plates and 78 text illustrations, 1927. Published by the author, 501 Edwards-Wildey Bldg., Los Angeles, Calif. This work is an exceptionally fine achievement and it should form part of the library of every lepidopterist. Our readers' attention is drawn to the review of this book by Dr. J. McDunnough in the "Canadian Entomologist", Vol. LIX, No. 6, 1927.

Contribution Towards a Knowledge of Our Canadian Plume Moths (*Lepidoptera*), by J. McDunnough, Trans. R.S.C., Section V, 1927. This paper contains critical notes, description of new species, records of distribution and reference to food plants; it is illustrated by two plates.

Synopsis of the Canadian Stratiomyidae (*Diptera*), by C. H. Curran, Trans. R.S.C., Section V, 1927. An important contribution to an interesting group of flies. Keys and distributional records are given to all known Canadian species.

NOTES OF CAPTURES

Species preceded by an asterisk (*) described since the last "Record" was prepared.

LEPIDOPTERA

(Arranged according to Barnes and McDunnough's "Check List of the Lepidoptera.")

Papilionidae

* *Papilio eurymedon albanus* form *columbiana* Gund. Kaslo, B.C., (Cockle). Ent. News, XXXVIII, 1927.

Satyridae

* *Satyrodes canthus* aber. *boweri* Cherm. Port Hope, Ont., (H. L. Bower). Bull. Brook. Ent. Soc., XXII, 1927.

Nymphalidae

* *Vannessa virginiensis* form *simmsi* Gund. Montreal, Que., (H. M. Simms). Ent. News, XXXVIII, 1927.

Arctiidae

* *Arctia caja* race *waro* B. and Benj. Vancouver Isl. and New Westminister, B.C.
Bull. S. Cal. Acad. Sci., XXVI, 1927.

Noctuidae
2498 *Acronycta rubricoma* Gn. Pt. Pelee, Ont., (F. P. Ide).
3225 *Autographa microgamma* Hbn. Mer Bleue, Ottawa, Ont., (G. S. Walley).
3391 *Erebus odora* L. Rocky Pt., St. Barbes, N.F., (Mrs. C. Pittman).
3569 *Bomolocha atomaria* Sm. Pt. Pelee, Ont., (F. P. Ide).

Geometridae
4361 *Phasiane dislocaria* Pack. Pt. Pelee, Ont., (Ide).

Limacodidae
Prolimacodes badia Hbn. Pt. Pelee, Ont., (Ide).

Oecophoridae
Agonopteryx cogitata Braun. Kazubazua, Que., (McDunnough).
* *Depressaria carystopa* Meyr. Toronto, Ont., (Parish).
Exotic Microlepidoptera, Vol. III, 1927.

Coleoptera

Prepared by W. J. Brown
(Arranged according to Leng's Catalogue of Coleoptera)

Carabidae
341 *Dyschirius truncatus* Lec. Baldur and Aweme, Man., (N. Criddle).
342 *Dyschirius erythrocerus* Lec. Trenton, Ont., (Evans).
436 *Bembidion reqestum* Csy. Saskatoon, Sask., (King).
529 *Bembidion longulum* Lec. Medicine Hat, Alta., (Carr).
579 *Bembidion striola* Lec. Edmonton, Alta., (Carr).
588 *Bembidion tetracolum* Say. Medicine Hat, Alta.
591 *Bembidion honestum* Say. Medicine Hat, Alta., (Carr).
602 *Bembidion ephippigerum* Lec. Medicine Hat, Alta., (Carr).
618 *Bembidion umbratum* Lec. Medicine Hat, Alta., (Carr).
655 *Bembidion intermedium* Kby. Medicine Hat, Alta., (Carr).
656 *Bembidion convexulum* Hayw. Edmonton, Alta., (Carr).
658 *Bembidion dorsale* Say. Cypress Hills, Alta., (Carr).
683 *Bembidion insulatum* Lec. Medicine Hat, Alta., (Carr).
754 *Bembidion sulcatum* Lec. Saskatoon, Sask., (King).
1127 *Cryobius riparius* Dej. Edmonton, Alta., (Carr).
1240 *Curtonotus laticollis* Lec. Medicine Hat, Alta., (Carr).
1442 *Rembus laticollis* Lec. Medicine Hat, Alta., (Carr).
1667 *Lebia ornata* Say. Chelsea, Que., (Kitto).
1675 *Lebia scapularis* Dej. Ottawa, Ont., (Harrington); Trenton, Ont., (Evans); Hull, Que., (Kitto); Aweme, Man., (White).
1679 *Lebia depicta* Horn. Swift Current, Marengo and Wenoncha, Sask., (King).
18981 *Lebia canonica* Csy. Kentville, N.S., (Gorham); Aweme, Man., (White); Ottawa, Ont., (Harrington); Hull, Que., (Kitto).

Amphizoidae
2280 *Amphizoa insolens* Lec. Banff, Alta., (Darlington).
Amphizoa striata Van Dyke. Koksilah, V.I., (Darlington)

Haliplidae
2303 *Haliplus leopardus* Rbts. Brome Lake, Que., (Brown).
2306 *Haliplus subguttatus* Robts. Kazubazua, Que., (Brown).

Dytiscidae
19200 *Hydroporus crassulus* Fall. Lundbreck, Alta., (Carr).
19201a *Hydroporus obesus congruus* Lec. Beaver Creek and Banff, Alta., (Carr).
Hydroporus alaskanus Fall. Banff, Alta., (Carr).
19233 *Agabus oblongulus* Fall. Edmonton, Alta., (Carr).

Gyrinidae
2689 *Gyrinus dichrous* Lec. Fairy Lake and Kazubazua, Que., (Brown).
2695 *Gyrinus maculiventris* Lec. Fairy Lake, Que., (Brown).
2703 *Gyrinus pectoralis* Lec. Covey Hill and Kazubazua, Que., (Brown).
2706 *Gyrinus impressicollis* Kby. Fairy Lake and Kazubazua, Que., (Brown); Thunder Bay, Ont., (McInnes).
19249 *Gyrinus marginellus* Fall. Fairy Lake, Que., (Brown).
19250 *Gyrinus latilimbus* Fall. Fairy Lake and Kazubazua, Que., (Brown).
19251 *Gyrinus bifarius* Fall. Britannia, Ont., (Brown).
19255 *Gyrinus pugionis* Fall. Fairy Lake, Que., (Brown).
19257 *Gyrinus frosti* Fall. Kazubazua, Que., (Brown).
Gyrinus piceolus Blatch. Fairy Lake, Que., (Brown).

Hydrophilidae
19278 *Cymbiodyta acuminata* Fall. Edmonton and Castor, Alta., (Carr).

Silphidae
2991 *Hydnobius substriatus* Lec. Edmonton, Alta., (Carr); Banff, Alta., (Garrett).
2997 *Anisotoma humeralis* Horn. Agassiz, B.C., (Glendenning).
2998 *Anisotoma valida* Horn. Seven Isle, Que., (Waugh).
3003 *Anisotoma collaris* Lec. Edmonton, Alta., (Carr).
3016 *Cyrtusa blandissima* Zimm. Aweme, Man., (N. Criddle).
3021 *Leiodes globosa* Lec. Fairy Lake, Que., (Brown); Brookmere, B.C., (Bird).
3022 *Leiodes polita* Lec. Ottawa, Ont., (Harrington).

Staphylinidae
3315 *Thoracophorus costalis* Er. Hull, Que., (Harrington); Aweme, Man., (White).

Histeridae
6606 *Hister depurator* Say. Penobsquis, N.B., (Frost).
6723 *Paromalus aequalis* Say. Medicine Hat, Alta., (Carr).
6836 *Saprinus assimilis* Payk. Penobsquis, N.B., (Frost).
Saprinus carri Hatch. Saskatoon, Sask., (King).

Lycidae
6931 *Celetes basilis* Lec. Kazubazua, Que., (Ide).
6933 *Lopheros fraternus* Rand. Ont.
6945 *Plateros modestus* Say. Aweme, Man., (N. Criddle).

Lampyridae
6967 *Calyptocephalus bifaria* Say. Ottawa, Ont., (Harrington).
6974 *Lucidota californica* Mots. Banff, Alta., (Garrett).
6975 *Lucidota corrusca* L. Bathurst, N.B., (Fleming).
6978 *Lucidota nigricans* Say. Baldru, Man., (N. Criddle).

Cantharidae
7147 *Silis difficilis* Lec. Banff, Alta., (Garrett).
7153 *Silis vulnerata* Lec. Oliver, B.C., (Garrett).
7155 *Silis lutea* Lec. Victoria, B.C., (Downes).

Melyridae
7238 *Malachius aeneus* L. Medicine Hat, Alta., (Carr).
7254 *Malachius montanus* Fall. Midday Valley, B.C., (Stanley).
7255 *Malachius nigrinus* Fall. Midday Valley, B.C., (Stanley).
7282 *Pseudebaeus oblitus* Lec. Covey Hill, Que., (Brown).
* *Trichochrous albertensis* Blais. Medicine Hat, Alta., 1924 (Carr). Pan. Pac. Ent., IV, 1927.
* *Listrus medicatus* Blais. Medicine Hat, Alta., 1924 (Carr). Pan. Pac. Ent., IV, 1927.
7503 *Dolichosoma foveicollis* Kby. Cranbrook, B.C., (Dennys).

Oedemeridae
7763 *Nacerda melanura* L. Medicine Hat, Alta., (Carr).

Pythidae
8216 *Rhinosimus pallipes* Boh. B. C.
8217 *Rhinosimus viridiaeneus* Rand. Kazubazua and Knowlton, Que., (Brown)

Pedilidae
8235 *Pedilus monticola* Horn. Saskatoon, Sask., (King).

Anthicidae
8301 *Notoxus nevadensis* Csy. Roadene, Sask., (King).

Elateridae
8607 *Monocrepidius auritus* Hbst. Medicine Hat, Alta., (Carr).
8616 *Aeolus livens* Lec. Medicine Hat, Alta., (Carr).
8622 *Limonius crotchi* Horn. Happy Valley and Pincher, Alta., (Carr).
8631 *Limonius aeger* Lec. Saskatoon, Sask., (King).
8632 *Limonius pectoralis* Lec. Cleeves, Sask., (King).
8644 *Pheletes occidentalis* Cand. Medicine Hat, Alta., (Carr).
8682 *Athous nigripilis* Mots. Medicine Hat, Alta., (Carr).
8708 *Ludius sjaelandicus* Mull. Swan Plain, Sask.
8710 *Ludius fusculus* Lec. Saskatoon, Sask., (King).
8725 *Ludius limoniiformis* Horn. Saskatoon, Sask., (King).

8730 *Ludius volitans* Esch. Beaver Creek, Alta., (Carr).
8733 *Ludius caricinus* Germ. Baithford, Sask.
8742 *Ludius lutescens* Fall. Edmonton, Alta., (Carr).
8753 *Ludius sagitticollis* Esch. Waterton, Alta., (Strickland).
8755 *Ludius fraternus* Lec. Pincher, Alta., (Carr).
8756 *Ludius ochreipennis* Lec. Banff, Alta., (Carr).
8769 *Ludius medianus* Germ. Redwater, Alta., (Carr).
8771 *Ludius fallax* Say. Waterton, Alta., (Strickland).
8780 *Ludius inflatus* Say. Magrath, Alta., (Carr).
8805 *Hemicrepidius carbonatus* Lec. Medicine Hat, Alta., (Carr).
8826 *Cryptohypnus abbreviatus* Say. Edmonton and Medicine Hat, Alta., (Carr).
8827 *Cryptohypnus impressicollis* Mann. Medicine Hat, Alta., (Carr).
8828b *Cryptohypnus nocturnis bicolor* Esch. Cleeves, Sask., (King).
8834 *Hypnoidus choris* Say. Aweme, Man., (N. Criddle).
8841 *Hypnoidus tumescens* Lec. Edmonton, Alta., (Carr); Creston, B.C., (Dennys).
8843 *Hypnoidus dubius* Horn. Winnipeg and Aweme, Man., (N. Criddle); Saskatoon, Sask., (King).
8846 *Hypnoidus gentilis* Lec. Sask.
8849 *Hypnoidus pectoralis* Say. Medicine Hat, Alta., (Carr).
8850 *Oedostethus femoralis* Lec. Medicine Hat, Alta., (Carr); Aweme, Man., (N. Criddle).
8882 *Sericus incongruus* Lec. Edwand, Alta., (Carr).
8894 *Agriotes limosus* Lec. Melfort, Sask., (King).
8898 *Agriotes nevadensis* Lec. Saskatoon, Sask., (King).
8902 *Agriotes montanus* Lec. Cypress Hills, Alta., (Carr).
8936 *Elater discoideus* Fab. Medicine Hat, Alta., (Carr).
8960 *Elater deletus* Lec. Medicine Hat, Alta. (Carr).
8969 *Elater nigricans* Germ. Medicine Hat, Alta., (Carr).
8988 *Megapenthes stigmosus* Lec. Yankee Bend, Sask., (Atkinson).
9084 *Cardiophorus longior* Lec. Macleod, Alta., (Carr).
9087 *Cardiophorus gagates* Er. Saskatoon, Sask., (King).

Melasidae
9179 *Anelastes druryi* Kby. Medicine Hat, Alta., (Carr).

Buprestidae
9370 *Buprestis maculativentris* Say. Penobsquis, N.B., (Frost).
9387 *Melanophila fulvoguttata* Harris. Castlereigh, N.S., (Frost); Penobsquis, N.B., (Frost).
9436 *Chrysobothris blanchardi* Horn. Penobsquis, N.B., (Frost).
9448 *Chrysobothris pusilla* Cast. Portaupique, N.S., (Frost).
9468 *Chrysobothris scabripennis* Cast. Castlereigh, N.S., (Frost); Penobsquis, N.B., (Frost).
9485 *Eupristocerus cogitans* Web. Penobsquis, N.B., (Frost).
9542 *Agrilus politus* Say. Mechanics' Lake, N.B., (Frost).

Helmidae
9619 *Helmis corpulenta* Lec. Beaver Creek, Alta., (Carr).
9630½ *Helmis ornata* Schaef. Lundbreck, Alta., (Carr).

Dermestidae
Trogoderma sinistra Fall. Edmonton and Medicine Hat, Alta., (Carr).

Nitidulidae
10023 *Meligethes saevus* Lec. Aweme, Man., (N. Criddle).
10025 *Meligethes mutatus* Har. Saskatoon, Sask., (King).
10069 *Omosita colon* L. Grand Harbor, N.B., (Wilson).
10117 *Pocadius helvolus* Er. Aweme, Man., (N. Criddle).
10129 *Cryptarcha ampla* Er. Fairy Lake, Que., (Brown).

Cucujidae
10194 *Oryzaephilus surinamensis* L. Edmonton, Alta., (Strickland).
10199 *Silvanus planatus* Germ. Medicine Hat, Alta., (Carr).
10246 *Laemophloeus liquidus* Csy. Medicine Hat, Alta., (Carr).

Cryptophagidae
10360 *Telmatophilus americanus* Lec. Covey Hill and Knowlton, Que., (Brown).
10370 *Antherophagus ochraceus* Melsh. Agassiz, B.C., (Glendenning); Saskatoon Sask., (King).
10384 *Cryptophagus acutangulus* Gyll. Saskatoon, Sask., (King).
10471 *Anchicera ochracea* Zimm. Broadview, Sask., (King).

Lathridiidae
10664 *Cartodere filum* Aube. Winnipeg, Man., (Mitchener).

Phalacridae
10780 *Olibrus semistriatus* Lec. Birch Hills, Sask., (King).

Coccinellidae
11150 *Psyllobora viginti-maculata* Say. Waldeck, Sask., (King).
11154 *Anisosticta bitriangularis* Say. Saskatoon, Sask., (King).
11183 *Coccinella tricuspis* Kby. Kelso, Sask., (King).
11185a *Coccinella transversoguttata quinquenotata* Kby. Tofield, Alta., (Carr).
11187 *Coccinella monticola* Muls. Macleod, Alta., (Carr).
11231 *Epilachna corrupta* Muls. Leamington and Chatham, Ont., (Thompson).

Tenebrionidae
11936 var. *Eleodes extricata convexicollis* Blais. Richmond, Sask., (King).
11985 *Eleodes pimelioides* Mann. Pincher, Alta., (Carr).

Melandryidae
12555 *Phryganophilus collaris* Lec. Vancouver, B.C.
12598 *Stenotrachelus aeneus* Fab. Vernon, B.C., (Downes); Hanna, Alta., (King).

Ptinidae
12601 *Mezium americanum* Lap. Ottawa, Ont., (Curran); Montreal, Que.
12621 *Ptinus californicus* Pic. Aylmer, Que., (Viereck).

Anobiidae
12660 *Ernobius nigricans* Fall. Oliver, B.C., (Garrett).
12686 *Oligomerus obtusus* Lec. Hemmingford, Que., (Armstrong).
12703 *Anobium punctatum* DeG. Yarmouth, N.S.
12706 *Hadrobregmus linearis* Lec. Bathurst, N.B., (Knull).
12707 *Hadrobregmus pusillus* Fall. Wilmot, N.S.
12709 *Hadrobregmus umbrosus* Fall. Stoke, Que.
12711 *Microbregma emarginatum* Duft. Ft. Coulonge, Que., (Beaulieu); Frater, Ont., (Watson); Banff, Alta., (Garrett).
12711a *Microbregma emarginatum granicollis* Fall. Salmon Arm, B.C., (Buckell).
12717 *Trypopitys sericeus* Say. Hemmingford, Que., (Hammond).
12722 *Vrilletta blaisdelli* Fall. Victoria, B.C., (Downes).
12723 *Vrilletta expansa* Lec. Duncan, B.C., (Hanham).
12864 *Ptilinus ruficornis* Say. Hemmingford, Que., (Armstrong).
12867 *Ptilinus lobatus* Csy. Aweme, Man., (N. Criddle).
12868 *Ptilinus pruinosus* Csy. Covey Hill, Que., (Armstrong).

Bostrichidae
12874 *Scobicia declivis* Lec. Salmon District and Victoria, B.C., (Downes).
12898 *Lichenophanes armiger* Lec. Aweme, Man., (N. Criddle).
12900 *Lichenophanes truncaticollis* Lec. Ontario.
12913 *Stephanopachys rugosus* Oliv. Kentville, N.S., (Gorham).
12918 *Stephanopachys cribratus* Lec. Ottawa, Ont., (Harrington).
12930 *Psoa quadrisignata* Horn. V.I.

Scarabaeidae
13041 *Canthon praticola* Lec. Melita, Man., (Robertson); Palmer, Sask., (King).
13045a *Canthon simplex corvinus* Har. Cranbrook, B.C., (Garrett).
13047 *Canthon vigilans* Lec. West Ontario.
13082 *Onthophagus orpheus* Panz. Aweme, Man., (N. Criddle); Onah, Man., (Wallis). Recorded in error as *janus*.
13098 *Aegialia cylindrica* Esch. Banff and Edmonton, Alta., (Carr).
13099 *Aegialia lacustris* Lec. Beaver Creek, Alta., (Carr); Midday Valley, B.C., (Cutler).
13102 *Aegialia conferta* Horn. Midday Valley, B.C., (Auden).
13108 *Aphodius validus* Horn. Montreal, Que.; Aweme, Man., (N. Criddle); Lethbridge, Alta., (Seamans).
13115 *Aphodius bidentatus* Schm. Bear Flat, B.C., (Vroom).
13120 *Aphodius sigmoideus* Van D. Skagit River, B.C.
13121 *Aphodius congregatus* Mann. Banff, Alta., (Garrett).
13123 *Aphodius putridus* Hbst. Edmonton, Alta., (Carr).
13151 *Aphodius explanatus* Lec. Moose Jaw, Sask.; Medicine Hat and Olds, Alta., (Carr and Chrystal); Nelson, B.C., (Fletcher).
19947 *Aphodius canadensis* Garn. Waterton, Alta., (Seamans).
13160 *Aphodius iowensis* Wickh. Aweme, Man., (N. Criddle).

13185 *Aphodius pardalis* Lec. Powell River and Royal Oak, B.C., (Downes).
13186 *Aphodius leopardus* Horn. Edmonton and High River, Alta., (Carr); Shuswap Indian Reserve, B.C.
13253 *Rhyssemus sonatus* Lec. Roche Percee, Sask., (S. Criddle).
13290 *Geotrupes balyi* Jek. Kingsmere, Que., (Chrystal); Cobalt, Ont.
13317 *Amphicoma canina* Horn. Agassiz, B.C., (Ross).
13511 *Phyllophaga fusca* Froel. Knowlton, Que., (Brown).
13709 *Anomala binotata* Gyll. Guelph, Ont., (Sanders).
13741 *Pachystethus lucicola* Fab. Colebrook, Ont., (Hewitt).
13780 *Pocalta rubripennis* Csy. Victoria, B.C., (Hanham).
13870 *Aphonus aterrimus* Csy. Ft. Coulonge, Que., (Beauline); East Ontario.
13904 *Xyloryctes lacustris* Csy. Trenton, Ont., (Evans).
13973 *Cremastocheilus canaliculatus* Kby. Ft. Coulonge, Que., (Beauline).
14022 *Trichiotinus assimilis* Kby. Covey Hill, Que., (Brown); Ottawa, Ont., (Fletcher); Aweme, Man., (Criddle); Salmon Arm, B.C., (Dennys). Recorded in error as *affinis*.

Cerambycidae

* *Eumichthus oedipus ruber* H. and P. Sidney, B.C., 1926 (Preece). Pan. Pac. Ent., III, 1927.
* *Eumichthus oedipus ates* Hardy and Preece. Sidney, B.C., 1926 (W. H. A. Preece). Pan. Pac. Ent., III, 1927.
14403 *Acmaeops proteus* Kby. Penobsquis, N.B., (Frost).
14482 *Strangalia subhamata* Rand. Penobsquis, N.B., (Frost).
14520 *Leptura chrysocoma* Kby. Penobsquis, N.B., (Frost).
14525 *Leptura proxima* Say. Kingston, N.B., (Frost).
14532 *Leptura mutabilis* Newn. Westchestor Lake, N.S., (Frost).
14543 *Typocerus velutinus* Oliv. Penobsquis, N.B., (Frost).
* *Semanotus ligneus Thujae* Van D. Vancouver Isl., B.C., 1925 (G. A. Hardy). Pan. Pac. Ent., Vol. III, 1927.
* *Callidium vancouverense* Van D. Sidney, B.C., (Hardy and Preece). Pan. Pac. Ent., III, Jan. 1927.
* *Phymatodes decursatus latifascatus* Hardy and Preece. Mount Tolmic, B.C., 1926 (G. A. Hardy). Pan. Pac. Ent., III, 1927.
* *Phymatodes vulneratus nigrescens* Hardy and Preece. Sidney, B.C., 1926 (W. H. A. Preece). Pan. Pac. Ent., III, 1927.
14713 *Neoclytus muricatulus* Kby. Westchestor Lake, N.S., (Frost); Penobsquis, N.B., (Frost); Saskatoon, Sask., (Atkinson).
14728 *Anthoboscus ruricola* Oliv. Penobsquis, N.B., (Frost).
15026 *Graphisurus pusillus* Kby. Penobsquis, N.B., (Frost).
Saperda bipunctata Hopping. Edmonton, Alta., (Carr).
15134 *Oberea schaumi* Lec. Wenoncha, Sask., (King).

Chrysomelidae

15194 *Donacia hirticollis* Kby. Kingston, N.B., (Frost); Castlereigh, N.S., (Frost).
15198 *Donacia proxima* Kby. Kingston, N.B., (Frost); Bilby, Alta., (Bryant).
15199 *Donacia palmata* Oliv. Castlereigh, N.S., (Frost).
15203 *Donacia subtilis* Kunze. Penobsquis, N.B., (Frost).
15203 var. *Donacia subtilis fulgens* Lec. Norway Point, Ont., (McDunnough).
15213 *Donacia pusilla* Say. Kingston, N.B., (Frost).
15213a *Donacia pusilla pyritosa* Lec. Victoria, B.C., (Auden).
15215 *Donacia metallica* Ahr. Bathurst, N.B., (Knull).
15216 var. *Donacia emarginata pacifica* Schaef. Banff, Alta., (Garrett).
15216 var. *Donacia emarginata frosti* Schaef. Kazubazua, Que., (Brown).
15217 *Donacia flavipes* Kby. Mechanic's Lake, N.B., (Frost).
Donacia fulvipes Lac. Mechanic's Lake, N.B., (Frost).
Donacia biimpressa Mels. Lobo, Ont., (Wood).
Donacia biimpressa limonia Schaef. Knowlton, Que., (Brown).
15455a *Pachybrachys carbonarius janus* Fall. Duck Lake, Sask., (King).
15495 *Cryptocephalus venustus* Fab. Waseca, Sask., (King); Hemmingford, Que., (Hammond).
15521 *Diachus auratus* Fab. Wenoncha, Sask., (King).
15574 *Xanthonia villosula* Mels. Hemmingford, Que., (Hammond).
15636 *Prasocuris vittata* Oliv. Saskatoon, Sask., (King).
15638 *Prasocuris ovalis* Blatch. Strathclair and Aweme, Man., (E. and N. Criddle); Indian Meadows, B.C., (Hopping); Strathroy, Ont., (Hudson).
15652 *Zygogramma exclamationis* Fab. Lethbridge, Alta., (Seamans).
15653 *Zygogramma conjuncta* Rog. Medicine Hat, Alta., (Carr).
15671 *Calligrapha scalaris* Lec. Penobsquis, N.B., (Frost).
15673 *Calligrapha rowena* Knab. Strathroy, Ont., (Hudson).

15674 *Calligrapha philadelphica* L. Penobsquis, N.B., (Frost).
15674a *Calligrapha philadelphica spireae* Say. Penobsquis, N.B., (Frost).
15677 *Calligrapha bigsbyana* Kby. Penobsquis, N.B., (Frost).
15686 *Chrysomela flavomarginata* Say. Saskatoon, Sask., (King.)
15687 *Chrysomela basilaris* Say. Edmonton, Alta., (Carr); Vernon, B.C.
15709 *Lina tremulae* Fab. Toronto, Ont., (Milne).
20191 *Phytodecta notmani* Schaef. Nipigon, Ont.
15733 *Trirhabda convergens* Lec. Birch Hills, Sask., (King).
15755 *Monoxia puncticollis* Say. Gull Lake, Sask., (King).
20208 *Disonycha davisi* Schaef. Hemmingford, Que., (Armstrong).
15968 var. *Chalcoides helexines violacea* Melsh. Aylmer and Covey Hill, Que., (Brown.)
15982 *Epitrix cucumeris* Har. Kazubazua and Covey Hill, Que., (Brown).
15985 *Epitrix subcrinita* Lec. Agassiz, B.C., (Glendenning).
15996 *Chaetocnema perturbata* Horn. Fort a la, Sask., (King).
16010 *Chaetocnema opulenta* Horn. Medicine Hat, Alta., (Carr).
16049 *Longitarsus melanurus* Melsh. Covey Hill, Que., (Brown).
*16066 var. *Phyllotreta vittata lineolata* Chit. Ottawa, Ont., (Fletcher); Hemmingford, Que., (Armstrong).
*16071 var. *Phyllotreta decipiens ordinata* Chit. V.I.
* *Phyllotreta alberta* Chit. Edmonton, Alta., 1918 (F. S. Carr).
* *Phyllotreta albionica corusca* Chit. Nicola Lake, B.C., 1920 (R. Hopping).
* *Phyllotreta columbiana* Chit. Agassiz, B.C., 1923 (R. Glendenning).
* *Phyllotreta inconspicua* Chit. Medicine Hat, Alta., 1913 (Carr); Saskatoon, Sask., (K. M. King); Aweme, Man., (N. Criddle).
* *Phyllotreta oblonga* Chit. Edmonton, Alta., 1919 (F. S. Carr).
* *Phyllotreta brevipennis* Chit. Aweme, Man., 1926 (Criddle). The above sp. described in Ent. Amer. Vol. VIII, June, 1927.
16086 *Dibolia borealis* Chev. Covey Hill, Que., (Brown).
16126 *Uroplata porcata* Mels. Cypress Hills, Alta., (Carr).
16139 *Chelymorpha cassidea* Fab. Wenoncha, Sask., (King).
16152 *Chirida guttata* Oliv. Wenoncha, Sask., (King).

Mylabridae

16215 *Mylabris pauperculus* Lec. Victoria, B.C., (Downes).
16243 *Mylabris seminulum* Horn. Onah, Treesbank and Aweme, Man., (White); Saskatoon, Sask., (McMillan).
Mylabris prolixus Fall. Edmonton, Alta., (Carr). Recorded in error as *macrocerus*.

Curculionidae

16326 *Rhinomacer elongatus* Lec. Kazubazua, Que., (Brown).

Otiorhynchidae

* *Panscopus pallidus* Bucha. Kaslo, B.C., (R. C. Currie); Ainsworth, B.C. Proc. Ent. Soc. Wash., Vol. 29, 1927.
* *Panscopus costatus* Bucha. Chilliwack, B.C. (Taken in a toad stomach). Proc. Ent. Soc. Wash., 1927.
Brachyrhinus rugosostriatus Goeze. Toronto, Ont., (Crew); Agassiz, B.C., (Treherne); Smith's Cove, N.S.
16701 *Omias saccatus* Lec. Medicine Hat, Alta., (Carr).
16764 *Phytonomus meles* Fab. Covey Hill, Que., (Armstrong).
16874 *Hylobius confusus* Kby. Trinity Valley, B.C., (Hopping).
16919 *Grypidius equiseti* Fab. Lethbridge, Alta., (Gray).
17074 *Tychius picirostris* Fab. Covey Hill, Que., (Armstrong).
* *Curculio funicularis* Chit. Toronto, Ont., 1910 (J. Evans).
* *Curculio numenius* Chit. Ontario; Wawanesa, Man., (Mrs. E. Ellis); Aweme, Man., (Criddle).
* *Curculio exilis* Chit. Ottawa, Ont. These sp. described in Ent. Amer. Vol. VII, Dec., 1926.
17236 *Anthonomus nigrinus* Boh. Medicine Hat, Alta., (Carr).
17253 *Anthonomus tectus* Lec. Medicine Hat, Alta., (Carr).
17337 *Orchestes ephippiatus* Say. Invermere, B.C., (Dennys).
17338 *Orchestes sulicis* L. Agassiz, B.C., (Glendenning).
17340 *Orchestes parvicollis* Lec. Agassiz, B.C., (Glendenning); Edmonton, Alta., (Carr).
17345 *Orchestes pallicornis* Say. Edmonton, Alta., (Carr).
17345a *Orchestes pallicornis pallidior* Leng. Ottawa, Ont., (Harrington); Halifax, N.S.

17792 *Ceutorhynchus mutabilis* Dietz. Medicine Hat, Alta., (Carr).
17797 *Ceutorhynchus neglectus* Blatch. Laprairie, Que., (Brown).
17812 *Ceutorhynchus semirufus* Lec. Kazubazua, Que., (Brown).
17817 *Ceutorhynchus septentrionalis* Gyll. Kazubazua, Que., (Brown).
17832 *Pelenomus squamosus* Lec. Waterton, Alta., (Seamans).
17840 *Mecopeltus scoliasus* Dietz. Aweme, Man., (N. Criddle).
17841 *Rhinoncus pericarpius* Fab. Edmonton, Alta., (Carr); Laprairie, Que., (Brown).
17842 *Rhinoncus pyrrhopus* Boh. Edmonton, Alta., (Carr).
17844 *Phytobius velatus* Beck. Black Rapids, Ont., (Brown).
17845 *Phytobius griseomicans* Schwarz. Brome Lake, Que., (Brown); Cypress Hills and Medicine Hat, Alta., (Carr).
18027 *Cossonus quadricollis* Van D. Medicine Hat, Alta., (Carr).
* *Phloeophagus canadensis* Van D. Medicine Hat, Alta., (Carr); Victoria, B.C.,
18093 *Calendra graminis* Chit. Chappica Lake and Medicine Hat, Alta., (Carr).
18107 *Calendra striatipennis* Chit. Fish Lake, Sask., (N. Criddle).
18123 *Calendra minima* Hart. Lobo, Ont., (Wood); St. Thomas, Ont., (James)
Calendra memnonia Gyll. White Lake, B.C., (Criddle and Vroom).
18157 *Sitophilus granarius* L. Medicine Hat, Alta., (Strickland).

Diptera

Prepared by C. H. Curran.

The numbers at the left refer to the page in Aldrich's Catalogue on which the name of the genus appears, while * refers to newly described species.

Tipulidae
89* *Limnophila aldrichi* Alex. Banff, Alta., (Garrett).
* *Limnophila columbiana* Alex. Prince Rupert, B.C., (Dyar).
The above two species described in Proc. U. S. N. M., Vol. 72, 1927.
* *Limnophila irene* Alex. Bothwell, Ont., 1925 (G. S. Walley).
Bull. Brook. Ent. Soc., Vol. XXII, 1927.

Simuliidae
* *Prosimulium novum* Dyar and Shan. Kaslo, B.C., (Dyar).
* *Prosimulium dicum* D. and S. Prince Rupert, B.C., (Dyar).
* *Prosimulium pancerastes* D. and S. Prince Rupert, B.C., (Dyar); White Horse, Y.T., (Clark); Dawson, Y.T., (J. K. Jessup).
* *Eusimulium mutum permutatum* D. and S. Kaslo, B.C., (R. P. Currie).
168* *Simulium decarum katmai* Dyar and Shan. Carcross, Y.T., and White Horse, Y.T., (Dyar).
The above described in Proc. Nat. Mus., LXIX, 1927.

Stratiomyidae
178* *Chrysochroma canadensis* Curr. Niagara Glen, Ont., 1926 (Walley).
184* *Odontomyia truquii innotata* Curr. Riding Mountains, Man., (G. S. Brooks).
188* *Euparyphus limbiventris* Curr. Aweme, Man., (Criddle and Bird).
* *Euparyphus latelimbatus* Curr. Waterton, Alta., (H. L. Seamans); Slave Lake, Alta., (O. Bryant).
* *Euparyphus nicolensis* Curr. Nicola, B.C., (Criddle).
* *Euparyphus octomaculatus* Curr. Penticton, B.C., (W. B. Anderson).
The above described in Trans. Ry. Soc. Can., Sec. V, 1927.

Tabanidae
195 *Chrysops brunneus* Hine. Pt. Pelee, Ont., July, (F. Ide).

Bombyliidae
235 *Bombylius fraudulentus* Johnson. Severn, Ont., June, (Curran).
245 *Toxophora amphitia* Walker. Saskatoon, Sask., June, (K. M. King).

Therevidae
246 *Psilocephala haemorrhoidalis* Macq. Pt. Pelee, June, 1922, (A. W. Baker); July, 1927, (F. Ide).

Asilidae
255 *Ospriocerus abdominalis* Say. Roche Percee, Sask., July, (Brooks).
270 *Dasyllis sacrator* Walker. Victoria Beach, Man., June, (G. S. Brooks).
272 *Laphria scorpio* L. Victoria Beach, Man., July, (Brooks).

Dolichopodidae
283* *Psilopus parvicauda* Van Duz. Wainfleet, Ont., (Van Duzee).
Ent. News, Vol. XXXVIII, 1927.
Rhaphium vanduzeei Curran. Kazubazua, Que., June, (Ide).

297 *Scellus virago* Ald. Roche Percee, Sask., July, (E. and S. Criddle, G. S. Brooks).

Syrphidae

376* *Copestylum caudatum* Curran. Medicine Hat, Alta., (F. S. Carr). Ent. News, Vol. XXXVIII, 1927.

359* *Platycheirus amplus* Curran. Low Bush, Lake Abitibi, Ont., (N. K. Bigelow); Spruce Brook, Newfoundland.

* *Platycheirus bigelowi* Curr. Low Bush, Lake Abitibi, Que., (Bigelow).

* *Platycheirus erraticus* Curr. Orillia, Ont., (Curran); St. Hilaire and Montreal, Que., (Beaulieu); St. Claud, Aweme and Goodlands, Man., (Criddle).

* *Platycheirus occidentalis* Curr. Oliver, B.C., (C. B. Garrett).

The above species described in Am. Mus. Novitates, No. 247, 1927.

Platycheirus scambus Staeger. Low Bush, Lake Abitibi, Ont., July, (N. K. Bigelow).

Platycheirus perpallidus Verr. Low Bush, Lake Abitibi, Ont., July, (N. K. Bigelow).

Platycheirus clypeatus Meigen. Low Bush, Lake Abitibi, Ont., July, (N. K. Bigelow).

Platycheirus scutatus Mg. Low Bush, Lake Abitibi, Ont., June, (N. K. Bigelow).

382 *Sericomyia sexfasciata* Walker. Cadray Bay, Nfld., July-Aug., (A. English).

Sapromyzidae

Sapromyzosoma fraterna Lw. Transcona, Man., July, (Brooks); Aweme, Man., Aug., (R. D. Bird).

Sapromyzosoma aequalis Mall. Transcona, Man., July, Roche Percee, Sask., July, (G. S. Brooks).

Sapromyzosoma harti Mall. Pt. Pelee, Ont., June, (Ide).

584 *Sapromyza brachysoma* Coq. Brockville, Ont., Oct., (W. Metcalfe).

Minettia obscura Mall. Hull, Que., June, (W. J. Brown); Niagara Glen, Ont., June, (G. S. Walley).

Trypaneidae

606 *Rhagoletis striatella* Wulp. Simcoe, Ont., Aug. 10, (L. Caesar).

Trypanea abstersa Lw. Roche Percee, Sask., July, (G. S. Brooks).

Tetanoceridae

579 *Tetanocera papillifera* Mel. Victoria Beach, Baldur and Winnipegosis, Man., July, Aug., (G. S. Brooks).

Scatophagidae

567* *Orthacheta brunneipennis* Johns. Hull, Que., (Curran) = *amoena* Cresson. The above species described in Psyche XXXIV, 1927.

Muscidae

536 *Pogonomyia similis* Mall. Pierson, Man., July, (H. J. Brodie).

542 *Trichopticus diaphana* Wd. Codroy Valley, Nfld., July-Aug., (A. English).

Lispoides aequalis Stein. Shell River, Man., July, (E. and S. Criddle).

Bigotomyia curvinervis Mall. Wilmot, N.S., Aug., (A. Dustan).

551 *Hydrophoria arctica* Mall. Nottingham Isld., Hudson Strait, Aug., (F. Johansen).

563 *Lispa nasoni* Stn. Transcona, Man., July, (G. S. Brooks).

572 *Allophyla laevis* Lw. Orillia, Ont., June, (Curran).

Sarcophagidae

476 *Opsidia gonioides* Coq. Pt. Pelee, Ont., July, (Ide).

476 *Gymnoprosopa polita* Towns. Pt. Pelee, Ont., June, (F. Ide).

Phrosinella fulvicornis Coq. Pt. Pelee, Ont., July, (Ide); Deloraine, Man., July, (E. and S. Criddle).

510 *Sarcophaga aculeata gavia* Ald. Roche Percee, Sask., July, 1927, (G. S. Brooks).

Sarcophaga hinei Aldrich. Victoria Beach, Man., July, (G. S. Brooks).

510 *Sarcophaga peniculata* Parker. Victoria Beach, Man., Aug., (G. S. Brooks).

Sarcophaga setigera Aldrich. Transcona, Man., July, (G. S. Brooks).

Tachinidae

422* *Gymnosoma occidentale* Curran. Vernon, B.C., (M. H. Ruhmann); Jordan, Ont., (W. A. Ross); Seton Lake, B.C., (McDunnough).

* *Phyllomya fuscicosta* Curran. Seton Lake, Lillooet, B.C., (J. McDunnough).

428* *Eulasiona tibialis* Curran. Aylmer, Que., (Curran).

449* *Belvosia canadensis* Curran. Piapot Reserve, Sask., (J. Fletcher); Calgary, Alta., Aweme, Man., (Criddle).
* *Belvosia splendens* Curr. Last Mountain, Sask., (C. H. Young); Baldur, Man., (R. D. Bird); Aweme, Man., (A. E. and S. Criddle).
The above five species described in Bull. Brook. Ent. Soc., Vol. XXII, 1927.
Cylindromyia decora Ald. Transcona, Man., July, (G. S. Brooks).
Cylindromyia compressa Aldrich. Aweme, Man., June, (J. B. Wallis).
421 *Vivania neomexicana* Tns. Kentville, N.S., July, Aug., (R. P. Gorham).

Hymenoptera

Ichneumonidae
* *Ischnopsidea alberta* Cush. Edmonton, Alta., (Geo. Salt).
* *Cryptus caligatus* Cush. Calgary, Alta., (Geo. Salt).
* *Agrothereutes rufopectus* Cush. Bilby, Alta., (Salt).
* *Protarchoides pallipes* Cush. Edmonton, Alta., (Salt).
The above species described in Proc. U. S. N. M., Vol. LXXII, 1927.

Anteoninae
* *Chelogynus rugulosus* Fent. St. Johns, N.B., (A. G. Leavitt).
* *Prenanteon micropunctatus* Fent. Nerepis, N.B., (Leavitt).
The above two species described in Proc. U.S.N.M., Vol. LXXII, 1927.

Eurytomidae
* *Harmolita kingi* Philp. Saskatoon, Sask., (K. M. King).

Serphoidea
* *Phaenopria occidentalis* Fouts. Chilliwak, B.C., (Oscar Whittaker).
* *Loxotropa nigrescens* Fouts. Chilliwak, B.C., (Whittaker).
* *Paramesius laetus* Fouts. Chilliwak, B.C., (Whittaker).
* *Calliceras whittakeri* Fouts. Chilliwak, B.C., (Whittaker).
These 4 species described in Proc. Ent. Soc. Wash., Vol. XXIX, 1927.

Megachilidae
* *Megachile wheeleri* Mitch. Calgary, Alta., (Geo. Salt).
Psyche, Vol. XXXIV, 1927

The following Alberta Ichneumonidae have been determined 1926 by Mr. R. A. Cushman of the United States Bureau of Entomology, Washington, D.C.; and unless otherwise indicated were collected by George Salt.

Acroricnus aequatus Say. Bilby; June.
Alexeter albotarsatus Prov. Calgary; August.
Amblyteles animosus Cress. Calgary; July, August.
Amblyteles animosus var. *rubellus* Cress. Calgary; August.
Amblyteles caeruleus Cress. Bilby; June.
Amblyteles cincticornis Cress. Edmonton, Bilby; May, June.
Amblyteles citatus Prov. Bilby; June.
Amblyteles citimus Cress. Bilby; June.
Amblyteles comes Cress. Calgary; June.
Amblyteles comes var. *aleatorius* Cress. Calgary; August.
Amblyteles discus Cress. Calgary; July.
Amblyteles feralis Cress. Edmonton; April, May.
Amblyteles gestuosus Cress. ? Bilby; June.
Amblyteles grandis Brulle. Calgary; July.
Amblyteles grotei Cress. Calgary; August.
Amblyteles instabilis Cress. ? Edmonton; May.
Amblyteles longulus Cress. Calgary; August.
Amblyteles maurus Cress. Bilby; June.
Amblyteles nubivagus Cress. Calgary; July.
Amblyteles nuncius Cress. Calgary; August.
Amblyteles ormenus Cress. Tofield; May, (Owen Bryant).
Amblyteles pedalis Cress. Calgary; May, July.
Amblyteles quadrizonatus Vier. Calgary; July.
Amblyteles robustus Cress. Edmonton; May.
Amblyteles rufiventris Brulle. Calgary; June.
Amblyteles scitulus Cress. Bilby; June.
Amblyteles subfuscus Cress. Calgary; May.
Amblyteles subrufus Cress. Edmonton, Tofield; May.
Amblyteles superbus Prov. Villeneuve, Edmonton; May, October (O. Bryant, George Salt.)

Amblyteles suturalis Say. Calgary; May.
Amblyteles suturalis var. *propinquus* Cress. Calgary; May.
Amblyteles uncinatus Cress. Edmonton; May.
Amblyteles variegatus Cress. Calgary; July, August.
Amblyteles vescus Prov. Bilby; June.
Apechthris picticornis Cress. Edmonton; April.
Arenetra nigrita Walsh. Edmonton; April.
Banchus flavescens Cress. Calgary, Bilby; June, July.
Catoglyptus fuscatus Cress. Bilby; June.
Clepsiporthus rubiginosus Cress. Bilby, Calgary; June, July.
Cteniscus clypeatus Cress. Bilby; June.
Cryptoideus bicolor Cush. Calgary; May.
Cryptus altonii D. T. Edmonton, Calgary; May, June, July.
Cryptus robustus Cress. Calgary; May, June.
Cylloceria sexlineata Say. Bilby; June.
Diaborus ornatus Walsh. Bilby; June.
Dialges frontalis Davis. Bilby; June.
Diplazon concinnus Cress. Bilby; June.
Diplazon laetatorius Fabr. Bilby; June.
Diplazon pulchripes Prov. Bilby; June.
Enicospilus purgatus Say. Burdett, Calgary; May, June, July, (W. R. and George Salt).
Ephialtes pedalis Cress. Burdett, Calgary, Bilby; May, August, (W. R. and George Salt).
Ephialtes tenuicornis Cress. Bilby; June.
Epiurus alborictus Cress. Calgary; May.
Erronmenus dimidiatus Cress. Bilby; June.
Exyston rufinus Davis. Calgary; July.
Glypta californica Prov. ? Calgary; August.
Glypta varipes Cress. Calgary; August.
Habronyx suburbe Davis. Calgary; May.
Hadrodactylus inceptus Cress. Bilby; June.
Homotropus humeralis Prov. Calgary; May.
Hoplismenus morulus Say. Bilby; June.
Hyposoter annulipes Cress. Calgary; July.
Ischnus exilis Prov. Calgary; August.
Lissonota americana Cress. Calgary; August.
Lissonota coloradensis Cress. Calgary; August.
Lissonota gelida Cress. Calgary; August.
Megarhyssa nortoni Cress. Calgary.
Mesochorus uniformis Cress. Bilby; June.
Opheltes glaucopterus var. *flavipennis* Prov. Calgary; September.
Ophion abnormis Felt. Calgary; May.
Paniscus pallens var. *barberi* Cush. Bilby; June.
Phytodietus burgessi Cress. Calgary; July.
Phytodietus distinctus Cress. Calgary; July, August.
Phytodietus vulgaris Cress. Calgary; July.
Polyblastus pedalis Cress. Bilby; June.
Polyblastus varitarsus Grav. Bilby; June.
Polysphincta texana Cress. Bilby; June.
Promethes unicinctus Ashm. Calgary; May.
Sagaritis intermedius Vier. ? Calgary; May.
Scopesis laetus Prov. Calgary; August.
Sesioplex validus Cress. Bilby; June.
Synoecetes festivus Cress. Bilby; June.
Syrphoctonus maculifrons Cress. Calgary; May, June.
Syrphoctonus pleuralis Cress. Bilby; June.
Therion fuscipenne Prov. Burdett; July, (W. R. Salt).
Theronia fulvescens Cress. Edmonton; May.
Trematopygus semirufus Cress. Bilby; June.
Tromatobia rufopectus Cress. Bilby; June.
Tryphon communis Cress. Bilby; June.

Tryphon communis var. *atripes* Davis. Bilby; June.
Viereckiana laticincta Cress. Calgary; July, August.
Viereckiana villosa Nort. Calgary; August.
Xorides insularis Cress Calgary; August.
Xorides stigmapterus Say. Bilby; June.
Cryptus relativus Cress. Vernon, B.C.; July, (H. G. Glover).
Glypta simplicipes Cress. Vernon, B.C.; July, (H. G. Glover).
Theronia fulvescens Cress. Vernon, B.C.; July, (H. G. Glover).

HEMIPTERA

Miridae

* *Deraeocoris piceicola* Kt. Simpson Pass and Barkerville, B.C., (E. R. Buckell); Revelstoke, B.C., (McDunnough).

The above species described Bull. Brook. Ent. Soc., Vol. XXII, 136, 1927.

* *Ceratocapsus downesi* Kt. Saanich and Victoria, B.C., (W. Downes).

The above species described in Ohio Journal of Science, Vol. XXVII, 151, 1927.

INDEX

Page
Aedes campestris 48
Aedes canadensis 49
Aedes cataphylla 48
Aedes cinereus 46
Aedes communis 48
Aedes dorsalis 46
Aedes excrucians 49
Aedes flavescens 49
Aedes hirsuteron Theo 8, 46
Aedes intrudens 48
Aedes nigromaculis 49
Aedes pullatus 48
Aedes punctor 46
Aedes spencerii 49
Aedes vexans Mgn 8, 46
Argotis fennica Tausch 7
Alabama argillacea 17
Allantus cinctus Linn 70
Allononyma vicarialis Zell 12, 38
Alsophila pometaria Harr 9, 11
Amorbia humerosana Clem 39
Amphorophora lactucae Kalt 23
Ancylis nubeculana 16
Anisota senatoria S. & A. 24
Anomala orientalis 60
Anopheles maculipennis 47
Anthonomus signatus Say 13
Anthrenus scrophulariae L. 15
Anuraphis cardui L. 22
Anuraphis roseus Baker 16, 20
Apanteles thompsoni Lyle 56
Aphids 8, 9, 13
Aphis avenae Fab 10
Aphis brassicae 18
Aphis maidis Fitch 14, 24
Aphis pomi DeG 9, 16, 20
Aphis pseudobrassicae 18
Aphis rumicis L. 13
Aphodius pardalis Lec 59
Apple aphids 16
Apple bud aphid 10
Apple leaf hopper 16, 21
Apple leaf sewer 16
Apple leaf trumpet miner 10
Apple maggot 10, 16, 19
Apple red bug 10, 22
Apple seed chalcid 10
Army cutworm 76, 85
Argyroploce variegana Hbn 11, 33
Aspidiotus perniciosus 15, 19
Attagenus piceus Oliv 15
Barathra configurata Wlk 50
Baryodma ontarionis Casey 66
Bed bug 15
Beet leaf miner 62
Bibio nervosus Lw. 12
Bill bugs 18
Black army cutworm 7
Blackberry leaf miner 18
Black carpet beetle 15
Black cherry aphid 10, 17, 22
Blissus occiduus Barber 50
Brown tail moth 10

Page
Bucculatrix pomifoliella Clem 13
Budmoth 10, 21, 27
Burdock borer 9
Cabbage aphis 18
Cabbage flea beetle 25
Cabbage maggot 7, 24, 62
Cacoecia persicana Fitch 10, 35
Cacoecia rosaceana Harr 12, 31
Carpocapsa pomonella L. 11, 19, 73
Carrot rust fly 7, 13, 18, 24
Cephus cinctus Nort 50
Ceramica picta Harr 14
Cherry fruit fly 22
Chorizagrotis auxiliaris Grt 76, 85
Chrysanthemum midge 19
Chrysopa spp 12
Cicadula sexnotata Fall 51
Cigar case bearer 11, 21
Cimex lectularius L. 15
Coccinellidae 12
Codling moth 11, 15, 19, 73
Colorado potato beetle 7, 14
Columbine borer 19
Common eel worm 13
Conotrachelus nenuphar 17, 22
Corn ear worm 14, 18
Corn leaf aphid 14, 24
Cotton moth 17
Cottony maple scale 13
Cottony peach scale 17
Cryptohypnus nocturnus Esch 50
Currant aphids 23
Currant fruit fly 13
Cutworms 18, 23
Cydia pomonella 15
Datana ministra 16
Diamond back moth 13
Diarthronomyia hypogaea 19
Dioctes punctoria Roman 55
Dissosteira carolina L. 14
Eastern tent caterpillar 8, 16, 21
Ellopia fiscellaria Gn 24
Empoa rosae L. 12
Empoasca fabae 16
Empoasca unicolor LeB 12
English grain aphid 51
Epiblema carolinana Walsingham 73
Epilachna corrupta Muls 39, 41
Epitrix cucumeris Harr 14
Epochra canadensis Lowe 13
Eriocampoides limacina Retz 8, 17, 22
Eriophyes pyri Pagnst 13, 16, 22
Eriosoma lanigera Hausm 10, 21
Erythroneura sp 23
Exeristes roborator Fab 55
Eulecanium sp 17
Eulia mariana Fern 11, 36
Eulia quadrifasciana Fern 36, 38
Eulimneria crassifemur Thom 55
European apple sucker 11
European corn borer 7, 9, 24, 55, 56
European red mite 11, 23
European rose sawfly 70

	Page
Euxoa ochrogaster	50
Euxoa tessellata Harr.	23
Exeristes roborator Fab.	55
Fall canker worm	9, 11
Fall web-worm	14
False Crane Flies	15
Flea beetle	14
Forest tent caterpillar	8, 21
Four lined leaf bug	14
Golden-glow borer	73
Gracilaria syringella Fab.	8, 25
Grape berry moth	23
Grape leaf hopper	23
Grape vine flea-beetle	23
Grapholitha molesta	17
Graptolitha bethunei G. & R.	12
Grasshoppers	14
Gray-banded leaf roller	11
Green apple aphid	9, 20
Green apple bug	12, 16
Green budworm	11
Green fruit worm	12
Haltica chalybea Tll.	23
Haploptilia fletcherella Fern.	11, 21
Haploptilia laricella Hb.	14
Haploptilia malivorella Rly.	13
Heliothis obsoleta Fab.	14, 18
Hemerocampa leucostigma S. & A.	8, 15
Hemlock looper	24
Hessian fly	9, 51
Heterodera radicicola Greef.	13
Hickory plant bug	17
Hop aphis	25
House flies	8, 15, 43
Hyalopterus arundinis Fab.	22
Hydroecia micacea Esp.	14
Hylemyia antiqua Meig.	9, 18, 24, 61
Hylemyia brassicae Bouche	7, 24, 62
Hylemyia cilicrura Rond.	18, 24
Hyphantria cunea Dru.	14
Illinoia solanifolii Ash	7, 14
Imported cabbage worm	7, 9, 18
Imported currant worm	13
June beetles	14
Lace wing fly	12
Lady bird beetles	12
Larch case bearer	14
Larch sawfly	14
Laspeyresia molesta Busck	22
Leaf hoppers	12
Leaf roller	27
Leaf sewer	12
LeConte's sawfly	8
Lepidosaphes ulmi L.	13
Leptinotarsa decemlineata Say	7, 9, 14
Leucopis griseola Fall	9
Lilac leaf miner	8, 25
Limax spp.	14
Ludius aereipennis tinctus Lec.	50
Lyctus sp.	25
Lygaeonematus erichsoni Hart.	14
Lygidea mendax Reut.	10, 22
Lygus caryae	17
Lygus communis Knight	12, 16
Lygus omnivagus	17
Lygus pratensis L.	7, 14, 17
Lygus quercalbae	17
Macrocentrus abdominalis Fab.	56
Macrodactylus subspinosus Fab.	23
Macrosiphum granarium Kby.	51
Malacosoma americana Fab.	8, 12, 16, 21
Malacosoma disstria Hbn.	8, 21
Maple leaf cutter	8
Maple leaf midge	25
March fly	12
Masicera senilis Rond.	55
Metallus rubi	18
Mexican bean beetle	39, 41
Microbracon brevicornis Wesm.	56
Microgaster tibialis Nees.	55
Millipedes	18
Monophadnoides rubi Harr.	18, 23
Mosquitoes	15, 45
Musca domestica L.	8, 43
Mushroom mite	25
Myzus cerasi Fab.	9, 10, 17, 22
Myzus ribis L.	23
Neodiprion lecontei Fitch	8
Nepticula pomivorella Pack.	13
Northwest chinch bug	50
Nygmia phaeorrhoea Donovan	10
Oak plant bug	17
Oat aphid	10
Oberea bimaculata Oliv.	7
Oblique-banded leaf roller	12
Onion maggot	9, 18, 24, 61
Orchard tent caterpillar	12
Oriental peach moth	17, 22
Oyster shell scale	13
Paleacrita vernata	16
Pale western cutworm	50
Pandemis limitata Rob.	10, 34
Papaipema cataphracta Grt.	9
Papaipema nitela Guen.	9
Papaipema purpurifascia	19
Paraclemensia acerifoliella Fitch	8
Paratetranychus pilosus C. & F.	11, 23
Paria canella Fab.	23
Peach tree borer	17
Pear leaf blister mite	13, 16, 22
Pear psylla	13, 16, 22
Pear slug	8, 17, 22
Pegomyia hyoscyami Panzer	7, 24, 62
Phaeogenes planifrons Wesm.	55
Phorodon humuli Schr.	25
Phyllophaga spp.	9, 14, 24
Phyllotreta albionica Lec.	25
Phytophaga destructor Say	9, 51
Pieris rapae L.	7, 9, 18
Pistol case bearer	13
Plum aphids	22
Plum curculio	17, 22
Plutella maculipennis Curtis	13
Poecilocapsus lineatus Fab.	14
Polychrosis viteana Clem.	23
Porosagrotis orthogonia Morr.	50
Potato aphis	7, 14
Potato beetle	9
Potato stem borer	14
Powder-post beetle	25
Psila rosae Fab.	7, 13, 18, 24
Psyllia mali Schmid.	11
Psyllia pyri	16
Psyllia pryicola Forst.	13, 22
Pteronidea ribesii Scop	13
Pulvinaria amygdali	17

Page
Pulvinaria vitis L. 13
Pyrausta nubilalis Hbn. 7, 9, 24, 74
Raspberry cane borer 7
Raspberry sawfly 18, 23
Red-backed cutworm 50
Red-humped apple caterpillar 16
Red-humped oak caterpillar 19
Rhabdophaga aceris 25
Rhagoletis cingulata Loew 22
Rhagoletis pomonella Walsh 10, 16, 19
Rhopalosiphum nymphaeae L. 22
Rhopalosiphum prunifoliae 16
Rhopalosiphum pseudobrassicae Davis 24
Ribbed cocoon maker of apple 13
Rose chafer 23
Rosy apple aphis 20
San Jose scale 15, 19
Sanninoidea exitiosa 17
Sap sucker 12
Schizura concinna 16
Seed corn maggot 18, 24
Septis artcica Bdv. 9
Serpentine leaf miner 13
Six-spotted leaf hopper 51
Slugs 8, 14, 18, 24
Sowbugs 18
Spenophorous sp. 18
Spilonota ocellana D. & S. 10, 12, 21, 29
Spinach leaf miner 7, 24

Page
Spiny oak worm 24
Spittle insects 8
Spring cankerworm 16
Stalk borer 9
Stored product pests 42
Strawberry leaf beetle 23
Strawberry weevil 13
Symmerista albifrons 19
Syntomaspis druparum Boh. 10
Syrphids 13
Tarnished plant bug 7, 14, 17
Tischeria malifoliella Clem. 10
Tortrix afflictana Wlk. 38
Trichogramma minutum 31
Turnip aphis 18, 24
Tussock moth 15
Typhlocyba pomaria McA. 21
Typhlocyba rosae 16, 22
Tyroglyphus lintneri 25
Wheat-stem sawfly 50
White grubs 9, 24
White-marked tussock moth 8
Wireworms 18, 24
Woolly apple aphid 10, 21
Yellow-headed cutworm 9
Yellow-necked caterpillar 16
Zebra caterpillar 14
Zenillia roseanae B. & B. 55

Ontario Department of Agriculture

FIFTY-NINTH ANNUAL REPORT

OF THE

Entomological Society

of Ontario

1928

PRINTED BY ORDER OF

HON. J. S. MARTIN, Minister of Agriculture

ONTARIO

TORONTO
Printed by the Printer to the King's Most Excellent Majesty
1929

ERRATA

Fifty-ninth Annual Report of the Entomological Society of Ontario, 1928

Page 60, the first line of second paragraph, for "possibility" read "impossibility."

Page 63, the first line, for "the trap crop" read "the crop."

Page 64, the third line of the first paragraph, for, "3.7" read "37.7."

CONTENTS

	Page
OFFICERS FOR 1928-29	4
FINANCIAL STATEMENT	4
Report of the Council	5
Report of the Curator and Librarian	7
Insects of the Season 1928 in Prince Edward Island: R. P. GORHAM	7
Insects of the Season 1928 in Nova Scotia: W. H. BRITTAIN	8
Insects of the Season 1928 in Nova Scotia: F. G. GILLIATT	10
Insects of the Season 1928 in New Brunswick: R. P. GORHAM, G. P. WALKER and L. J. SIMPSON	13
Insects of the Season 1928 in Quebec: C. E. PETCH	17
Insects of the Season 1928 in Ontario: W. A. ROSS and L. CAESAR	18
Insects of the Season 1928 in Manitoba: A. V. MITCHENER and NORMON CRIDDLE	22
Insects of the Season 1928 in Saskatchewan: ELLIS MCMILLAN	26
Insects of the Season 1928 in Northern Alberta: E. H. STRICKLAND	28
Insects of the Season 1928 in Alberta: H. L. SEAMANS	29
Insects of the Season 1928 in British Columbia: ERIC HEARLE	31
Insects of the Season 1928 Around Vancouver, Especially Point Grey: G. J. SPENCER	36
The Present Status of Corn Borer Parasites in Canada: A. B. BAIRD	38
Notes on the Life-History of the European Corn Borer in Ontario: GEO. M. STIRRETT	40
Corn Investigations in Relation to the European Corn Borer: A. R. MARSTON	43
The Percentage and Number of European Corn Borers Wintering in the Parts of Corn Stalks Below the Surface of the Ground: R. W. THOMPSON	46
The Corn Borer Situation in Ontario in 1928: L. CAESAR	49
A Method of Preparing Wax Entomological Exhibits: A. A. WOOD	52
The Laboratory Breeding of *Microgaster tibialis* Nees: W. ELGIN STEENBURGH	55
Notes on Myiasis of the Urinary Passage Caused by Larvae of *Fannia*: J. D. DETWILER	57
The Value of Trap Crops in the Control of the Wheat Stem Sawfly in Alberta: H. L. SEAMANS	59
Notes on the Life History of the Oriental Peach Moth at Vineland Station: THOS. ARMSTRONG	65
Parasitism of the Oriental Peach Moth in Ontario with Special Reference to Biological Control Experiments with *Trichogramma minutum* Riley: C. W. SMITH	72
Some Remarks on the Present Status of Insecticidal and Biological Control Investigations for the Oriental Peach Moth, *Laspeyresia molesta* Busck: ALVAH PETERSON	80
Notes on the Red Spider on Bush Fruits, *T. telarius* L.: W. G. GARLICK	86
The Apple Maggot Outbreak of 1926 to 1928: L. CAESAR	93
Six Years' Study of the Life History and Habits of the Codling Moth (*Carpocapsa pomonella* L.): J. ALLAN HALL	96
A Breeding Place of *Euphorbia inda* Linn., The Bumble Flower Beetle: G. J. SPENCER	106
Observations on *Myrmecophila oregonensis* Bruner (*M. formicarum Scudder*) in Relation to *Formica rufa* Linn: GEOFFREY BEALL	107
Notes on the Biology and Life-History of the Mexican Bean Bettle in Ontario: GEO. M. STIRRETT	107
The Entomological Record, 1928: NORMAN CRIDDLE	110
INDEX	125

Entomological Society of Ontario

OFFICERS FOR 1928-29

President—PROF. A. W. BAKER, B.S.A., O.A. College, Guelph.

Vice-President—PROF. J. D. DETWILER, University of West. Ontario, London, Ont.

Secretary-Treasurer—R. OZBURN, O.A. College, Guelph.

Curator and Librarian—MISS ROSE KING, O.A. College, Guelph.

Directors—Division No. 1, C. B. HUTCHINGS, Entomological Branch, Dept. of Agriculture, Ottawa; Division No. 2, C. E. GRANT, Orillia; Division No. 3, DR. NORMA FORD, Univ. of Toronto; Division No. 4, F. J. A. MORRIS, Peterborough; Division No. 5, DR. J. D. DETWILER, Western University, London; Division No. 6, H. F. HUDSON, Strathroy; Division No. 7, W. A. ROSS, Vineland Station.

Directors (ex-Presidents of the Society) REV. PROF. C. J. S. BETHUNE, Toronto; PROF. JOHN DEARNESS, London; JOHN D. EVANS, Trenton; PROF. E. M. WALKER, University of Toronto; ALBERT F. WINN, Westmount, Que.; PROF. LAWSON CAESAR, O.A. College, Guelph; ARTHUR GIBSON, Dominion Entomologist, Ottawa; MR. F. J. A. MORRIS, Peterborough; DR. J. H. SWAINE, Entomological Branch, Ottawa; REV. FATHER LEOPOLD, La Trappe, Que.

Editor of "The Canadian Entomologist"—DR. J. MCDUNNOUGH, Entomological Branch, Ottawa.

Delegate to the Royal Society of Canada—MR. A. GIBSON, Dominion Entomologist, Ottawa, Ont.

FINANCIAL STATEMENT

FOR THE YEAR ENDING OCTOBER 31ST, 1928

Receipts		*Expenditures*	
Cash on hand, 1927	$ 584.86	Printing	$1,410.00
Subscriptions	561.20	Annual Meeting	66.52
Dues	64.30	Expense	62.85
Advertisements	89.00	Cuts	31.23
Back Numbers	79.51	Salaries	290.00
Government Grant	1,000.00	Insurance	39.50
Bank Interest	14.53	International Congress of Entomology	100.15
Exchange	.15	Exchange	16.44
		Balance on hand	376.86
	$2,393.55		$2,393.55

By cash on hand	$ 376.86
To printing account payable	115.00
Net balance	$ 261.86

Respectfully submitted,

R. H. OZBURN,
Secretary-Treasurer.

Entomological Society of Ontario

REPORT OF THE COUNCIL

The Council of the Entomological Society of Ontario begs to present its report for the year 1927-1928.

The sixty-fourth annual meeting of the Society was held at Ottawa, on Thursday and Friday, November 17th and 18th.

The morning and afternoon meetings were held in the Chateau Laurier, and the Smoker in the Halcyon Club.

The Thursday evening meeting was held in the Lecture Hall of Victoria Museum when Dr. A. T. Charron, Assistant Deputy Minister of Agriculture, acted as chairman and Dr. L. O. Howard, Bureau of Entomology, United States Department of Agriculture, delivered the public lecture on "What Economic Entomology Means to the World," (illustrated). A moving picture film on parasite work with the corn borer was then shown.

The meetings were well attended by members from the various Provinces and a number of visitors.

During the course of the meeting the following papers were presented:

"Insects of the Season, District No. 1, Ottawa," (by title)—Mr. C. B. Hutchings, Entomological Branch, Ottawa.

"Insects of the Season, District No. 6, Strathroy," (by title)—Mr. H. F. Hudson, Entomological Branch, Strathroy.

"Insects of the Season in Ontario" (8 minutes)—Professor L. Caesar, Guelph, Ont., and Mr. W. A. Ross, Vineland Station, Ont.

"The Round-headed Apple-tree Borer, Saperda candida Fab., and its Control with Calcium Cyanide," (12 min.)—Mr. C. E. Petch, Entomological Branch, Hemmingford, Que.

"Some Experiments with Nicotine Dusts," (10 min.)—Mr. R. Glendenning, Entomological Branch, Agassiz, B. C.

"A Preliminary Report on Some of the Budmoths and Leafrollers in Nova Scotia," (12 min.)—Mr. F. C. Gilliatt, Entomological Branch, Annapolis Royal, N. S.

"Setting the Date for the August Codling Moth Spray," (20 min.)—Professor R. H. Pettit, Michigan State College of Agriculture and Applied Science, East Lansing, Mich.

"The Mexican Bean Beetle in Ontario," (10 min.)—Mr. L. S. McLaine, Entomological Branch, Otaawa.

"Some Notes on the Life-history of the Mexican Bean Beetle, Epilachna corrupta Muls., in Ontario," (8 min.)—Mr. H. F. Hudson, Entomological Branch, Strathroy.

Meeting adjourned at 12.30 p.m.

Meeting commenced at 2.00 p.m.

The following papers were read:

"Latest Developments in the Control of Stored Products Pests by Fumigation with Calcium Cyanide," (8 min).—Mr. C. H. Curran, Entomological Branch, Ottawa.

"A Cheap and Effective Fly Spray," (8 min.)—Mr. C. R. Twinn, Entomological Branch, and Mr. F. A. Herman, Division of Chemistry, Central Experimental Farm, Ottawa.

"Community Mosquito Control at Ottawa," (10 min.)—Mr. Arthur Gibson, Dominion Entomologist, Ottawa.

"The Problem of Mosquito Control in Inland Towns and Cities," (20 min.)—Dr. Robert Matheson, Cornell University, Ithaca, N. Y.

"Mosquito Control Activities in Western Canada," (10 min.)—Mr. Eric Hearle, Entomological Branch, Indian Head, Sask.

"International Aspects of Entomology"—Dr. L. O. Howard, Bureau of Entomology, U. S. Dept. of Agriculture, Washington, D.C.

"Observations on External Parasites of Certain British Columbia Birds," (10 min.)—Professor Geo. J. Spencer, University of B. C., Vancouver.

"Notes on the Respiratory System of Insect Larvae," (10 min.)—Mr. J. J. deGryse, Entomological Branch, Ottawa.

"Notes on Some Species of Palaearctic Coleoptera New to Canada and North America," (8 min.)—Mr. W. J. Brown, Entomological Branch, Ottawa.

"Recent Work on the Tarnished Plant Bug, Lygus pratensis L.," (5 min.)—Mr. R. H. Painter, Entomological Branch, Ottawa.

Meeting adjourned.

Public Meeting commenced, Thursday Evening, at 8.15 p.m.
Dr. A. T. Charron, Assistant Deputy Minister of Agriculture, Chairman.
"What Economic Entomology Means to the World," (Illustrated)—Dr. L. O. Howard, Bureau of Entomology, United States Department of Agriculture, Washington, D. C.
Meeting adjourned.
Commenced again Friday morning at 9.15 a.m.
Following were the papers read:
"The Late Professor Lochhead"—Rev. Father Leopold, D.Sc. A., Oka, Que.
"Forecasting Outbreaks of the Army Cutworm, Chorizagrotis auxiliaris Grt.," (8 min.)—Mr. H. L. Seamans, Entomological Branch, Lethbridge, Alta
"The Japanese Beetle and Methods for its Control," (10 min.)—Mr. Loren B. Smith, Japanese Beetle Laboratory, Riverton, N. J.
"Field Crop Insect Conditions in Saskatchewan, 1922-27," (10 min.)—Mr. K. M. King, Entomological Branch, Saskatoon, Sask.
"The 1927 Campaign Against the European Corn Borer in New York State," (15 min.) —Dr. M. D. Leonard, Cornell University, Ithaca, N. Y.
"The Corn Borer Act in Operation in Ontario," (10 min.)—Professor L. Caesar, Ontario Agricultural College, Guelph.
"Parasites of the European Corn Borer," (10 min.)—Mr. D. W. Jones, European Corn Borer Laboratory, Arlington, Mass.
"The Spread and Degree of Infestation of the European Corn Borer in Canada in 1927," (10 min.)—Mr. W. N. Keenan, Entomological Branch, Ottawa.
"The Occurrence of Aphodius pardalis Lec., in British Columbia," (8 min.)—Mr. W. Downes, Entomological Branch, Victoria, B. C.
"Habits of the Onion Root Maggot Fly, Hylemyia antiqua Mgn," (8 min.)—Mr. A. D. Baker, Macdonald College, Que.
"The Preparation for Shipment to New Zealand of the White Grub Parasite, Microphthalma michiganensis," (8 min.)—Mr. G. H. Hammond, Entomological Branch, Hemmingford, Que.
Meeting adjourned.
Meeting commenced at 2.00 p.m., Friday afternoon, and the following papers were read:
"Notes on the Natural Control of the White Marked Tussock Moth," (10 min.)—Mr. Georges Maheux, Provincial Entomologist, Quebec, Que.
"Insecticidal Treatment of Hardwoods," (12 min.)—Mr. Arthur Kelsall, Entomological Branch, Annapolis Royal, N. S.
"The Introduction and Establishment of the Larch Sawfly Parasite, Mesoleius tenthredinis Hew., in Southern Manitoba," (10 min.)—Mr. Norman Criddle, Entomological Branch, Treesbank, Man.
"The Canadian Insect Pest Survey," (10 min.)—Mr. C. R. Twinn, Entomological Branch, Ottawa.
"The Occurrence of Unpigmented Instars in Grylloblatta"—Dr. Norma Ford, University of Toronto.
"Further Notes on the Maple Leaf-cutter, Paraclemensia acerifoliella Fitch," (8 min.) —Mr. C. B. Hutchings, Entomological Branch, Ottawa.
"The Effect of Calcium Arsenate on Various Forest Trees," (10 min.)—Messrs. Arthur Kelsall and J. P. Spittall, Ent. Branch, Annapolis Royal, N. S.
"Forest Insect Conditions in Manitoba," (8 min.)—Mr. E. B. Watson, Entomological Branch, Ottawa.
"Observations on Shade-tree Insects in Saskatchewan," (8 min.)—Mr. K. E. Stewart, Entomological Branch, Ottawa.
"Notes on the European Rose Sawfly, Allantus cinctus," (8 min.)—Mr. R. P. Gorham, Entomological Branch, Fredericton, N. B.
"The Convolvulus Plume Moth, Oidaematophorus monodactylus L.," (8 min.)—Mr. R. M. White, Entomological Branch, Treesbank, Man.
"Notes on the Mossy Rose Gall," (8 min.)—Mr. W. B. Anderson, Victoria, B. C.
"The Golden Glow Borer," (8 min.)—Mr. R. Thompson, O.A.C., Guelph, Ont.
Meeting adjourned.

The Canadian Entomologist, the official organ of the society, completed its fifty-ninth volume in December last. The volume contained 304 pages illustrated by five full page plates and thirty-two original figures. The contributors to these pages numbered thirty-six and included writers in Ontario, Manitoba, Saskatchewan, British Columbia, New Brunswick, and also twenty-one in the United States, some in South America.

The International Congress of Entomology was held at Cornell University, Ithaca, N. Y., in August. Many members of our Society were in attendance at the sessions.

REPORT OF THE CURATOR AND LIBRARIAN

The Society's collections have been examined from time to time, and the necessary steps taken to prevent injury from museum pests. At the present time they are in good condition.

Numerous additions have been made to the Library. It is expected that the present alterations to the Library will soon be completed thereby greatly increasing our accommodation. This will enable the Library to be put into shape to be more readily available to members.

INSECTS OF THE SEASON 1928 IN PRINCE EDWARD ISLAND

R. P. GORHAM, DOMINION ENTOMOLOGICAL LABORATORY,
FREDERICTON, N. B.

A brief visit was made to different parts of Prince Edward Island in late August, 1928, when the following notes were made:

DIAMOND-BACK MOTH, *Plutella maculipennis* Curtis. Diamond-back moth was observed in numbers on Swede turnips at the Iona Illustration Station, Kings county. This insect occurred in outbreak numbers in New Brunswick in 1926 but has been rare during 1928.

GRASSHOPPERS, *Melanoplus bivittatus* Say and *M. atlanis* Riley were seen in moderate numbers at the Iona Illustration Station. Slight signs of feeding could be seen upon corn. Iona is in a sand soil area and is near the centre of the district where the last grasshopper outbreak occurred in 1923.

HESSIAN FLY, *Phytophaga destructor* Say. Small numbers of the "flax seed" form of hessian fly were found in roadside wheat in Prince county. Almost one-half of those found had been fungus-killed.

WHEAT JOINT WORM, *Harmolita tritici* Fitch. Injury caused by wheat joint worm was noted at several places in Prince and Queens counties and it would appear to be moderately common.

WIREWORMS—Were reported by the Superintendent of the Experiment Station to be troublesome in places on the island.

PEA MOTH, *Laspeyresia nigricana* Steph. This insect was very abundant and troublesome at the Charlottetown Experiment Station and reported by the assistant superintendent to be a common pest in the town gardens.

POTATO FLEA BEETLE, *Epitrix cucumeris* Harr. Potato flea beetle was moderately common in all fields of potatoes visited.

POTATO APHID, *Illinoia solanifolii* Ashm. Potato aphid was reported by the Superintendent of the Experiment Station and by the Chief Potato Inspector to have been very general in distribution and abundant in 1928. Numerous signs of their presence could be seen in dried skins and fungus-killed specimens on the plants, although most of the aphids had already left at the time of our visit.

CARROT RUST FLY, *Psila rosae* Fab. Evidence of injury caused by larvae of the spring generation of carrot rust fly was observed at the Charlottetown Experiment Station, although no insects were present at the first of September. It is reported to be generally common in town gardens.

APPLE MAGGOT, *Rhagoletis pomonella* Walsh. Apple maggot was noted abundant in Dudley winter apples at Charlottetown. It is reported to be still more or less local in distribution and to affect only the softer varities of apples.

FELTED BEECH COCCUS, *Cryptococcus fagi* Baernsp. Felted Beech coccus was noted abundant in a stand of beech in Prince county. Numerous young were moving over the bark on August 29.

FALL WEBWORM, *Hyphantria cunea* Drury. Fall webworm was noted as common on roadside trees in the eastern part of Kings county but scarce in Queens and Prince counties.

LARCH CASE-BEARER, *Haploptilia laricella* Hbn. Larch case-bearer was common in all parts of the province where stands of larch occurred.

PINE NEEDLE SCALE, *Chionaspis pinifoliae* Fitch. Pine needle scale was observed as present in small numbers on red pine at Charlottetown.

POTATO STEM BORER, *Gortyna micacea* Esp. Potato stem borer was not seen but was reported by the Assistant Superintendent of the Experiment Station to be troublesome in Charlottetown gardens in spring.

INSECTS OF THE SEASON 1928 IN NOVA SCOTIA

W. H. BRITTAIN

The observations of the writer on the prevalence of insect pests during the past season were confined largely to a comparatively small section of western Kings County. The following report, therefore, naturally falls far short of reflecting the pest situation in the province as a whole.

In general the season might be considered as a poor insect year and a favorable one for crop production. The scarcity of certain species, often abundant, was particularly noticeable and significant. The abnormal season of 1927 doubtless was an important factor in producing this result. While this is not the place to analyze the factors concerned, it is of interest to note that the total precipitation of 30.11 inches during the months of April to October inclusive far exceeds that of any year of which we have record, though the seasons of 1916 and 1917 were also very wet years. The combined precipitation during July and August of 14.53 inches is also much greater than that of any year for which records are available and, indeed, it is double that of any year for the past decade except 1922, when there was a precipitation of 9.18 inches during these two months In 1928 the rainfall was light and evenly distributed and the sunshine above normal.

THE EUROPEAN RED MITE (*Paratetranychus pilosus* Can & Franz.) which had been increasing in importance for several seasons was only abundant locally. The eggs were not nearly so numerous nor so widespread on the twigs in the spring and, though control measures were taken quite generally over the fruit belt—whether needed or not—and while these were, in most cases, effective, the scarcity of the pest throughout the summer could not entirely be attributed to spraying. It is evident that some undetermined natural control factor was at work.

THE GREEN APPLE APHIS (*Aphis pomi* DeG.) and the ROSY APHIS (*Anuraphis roseus* Baker) were little in evidence throughout the entire season. Contrary to the conditions existing in 1927 the eggs were scarce in the spring, while the climatic conditions existing throughout the season were not particularly favourable to the aphids, though favourable to the development of their natural enemies. This is also quite the reverse of conditions existing in 1927, when excessive wet weather produced a vigorous succulent growth of shoots favouring the increase of *A. pomi* and apparently inhibiting the natural enemies of the aphids.

There was also a marked scarcity in numbers of the apple sucker (*Psyllia mali* Schmidb.), induced by the wet weather of the previous summer which favoured the development of the fungus, *Entomophthora sphaerosperma*. The insect, however, though not generally numerous was

widespread, being present to at least a slight extent in all orchards examined.

THE EYE-SPOTTED BUD MOTH (*Spilonota ocellana* D. and S.) is another insect which appears to have been steadily and generally increasing during the past few years and its control has become a matter of first class importance to the fruit industry. There is no doubt that, as far as the district known to the writer is concerned, there was a marked and general reduction of the pest. How much of this was due to the greatly increased efficiency of the sprays generally used to control this pest it would not be possible to say.

The real feature of the season, as far as orchard pests were concerned, was the sudden and uniform increase throughout the entire Valley of the green apple bug (*Lygus communis* Knight). Not only was the insect more numerous than it has been for several years past, but its injury was greater than would have been expected from its numbers. This was due to the fact that the "set" of fruit was rarely heavy anywhere or with any variety, with the result that the nymphs concentrated on the fruit that did set and caused serious loss in many cases. The insect has never been generally numerous since 1919 and 1920, when, after reaching a peak, the epidemic suddenly waned, due to the work of the fungus, *Empusa rupta* Dustan. This fungus apparently rarely becomes effective until the insects in an orchard reach a very considerable concentration of numbers.

A new food habit of the green apple bug was observed during the past season. It has already been recorded by the writer that the food preference of adult bugs is quite different from that of the nymphs, the former showing a marked preference for the fruit of pears especially Bartletts, while the fruit of plums is also often attacked where available. The insect actually breeds very sparingly in the pear in Nova Scotia, though this plant is said to be the chief host of New York, and does not breed at all in the plums. During the past season, on investigation of a report of damage to rose blossoms, a mixed infection of this insect and the tarnished plant bug was discovered with the former greatly predominating. An examination of hollyhocks in the same garden showed also a mixed infection with tarnished plant bug predominating. A heavy dusting of nicotine dust (4% of actual nicotine) put an end to the depredations of the green apple bug.

Another pest for which we must report an increase is the white marked tussock moth (*Hemerocampa leucostigma* S. and A.) This species also was more numerous than for several years past and injury to fruit was common and widespread.

THE CANKER WORM (*Alsophila pometaria* Harris) was locally abundant in orchards where spraying has been wanting or imperfect, and several of the smaller or non-commercial orchards were defoliated. In one orchard under observation large numbers of larvae entered pupation along the edge of the sod strip. When examined in September, however, it was found that the greater number had been destroyed by an undetermined fungus.

Fruit worm injury was quite noticeable in many orchards, but this may have been due rather to the light set than to the greater prevalence of this insect.

THE APPLE AND THORN SKELETONIZER (*Simaethis pariana* Clerck) has spread with extraordinary rapidity since its introduction a few years ago. Entering by the western gateway, probably at Yarmouth, it has spread through Annapolis and Digby counties into Kings and Hants, where its work was, for the first time quite conspicuous in many orchards.

It was even found in back districts remote from the main highway. The writer found it, for example, on a few wild apple trees fifteen miles south of Windsor on the Chester Road.

No outbreaks of outstanding importance to small fruits or general farm crops were noted and complaints of such damage were less than for several years.

THE STRAWBERRY WEEVIL (*Anthonomus signatus* Say), was present in very small numbers in the strawberry plantations. Complaints of cut worms were less than usual. The garden springtail (*Sminthurus hortensis* Fitch) was much in evidence in certain localities attacking beets, mangolds and field turnips. Four lined leaf bugs (*Poecilocapsus lineatus* Fab.) were abundant on both cultivated plants and weeds especially hemp nettle.

INSECTS OF THE SEASON 1928 IN NOVA SCOTIA

F. C. GILLIATT, DOMINION ENTOMOLOGICAL LABORATORY,
ANNAPOLIS ROYAL, N. S.

FRUIT INSECTS

GREEN APPLE APHID, *Aphis pomi* DeG.—At no time during the year did the green apple aphis cause material damage. In the early summer it was present in rather alarming numbers in a few orchards that had started a succulent growth. This growth was checked by continuous dry weather and all danger from this pest was eliminated.

ROSY APPLE APHID, *Anuraphis roseus* Baker.—On twigs forwarded to the laboratory from many localities during the winter, eggs of this species were usually present. In the early spring nymphs were more or less general. Weather conditions, however, were not favorable and no outbreaks occurred.

WOOLLY APPLE APHID, *Eriosoma lanigera* Hausm.—This insect is ordinarily only present in small numbers, and is not considered an apple pest of importance in the Annapolis valley. During the summer of 1928, however, there was a decided increase, being particularly noticeable on the current year's growth causing the typical swelling of the new wood around the buds.

BLACK CHERRY APHID, *Myzus cerasi* Fab.— This aphid was observed infesting young cherry trees at Annapolis and in the Bear River cherry district. Wherever found it was numerous enough to check normal growth.

APPLE MAGGOT, *Rhageletis pomonella* Walsh.—In Digby and the western part of Annapolis counties, where outbreaks of this insect have been occurring for some time the intensity in 1928 was somewhat less than last year. This also applies to Hants county where there has been a mild infestation for the past few years. An adult was caught in the centre of the fruit growing district at Berwick during the summer. The first adult fly to appear in cages was on July 9 at Acadiaville. An adult was observed in the orchard as late as September 13.

APPLE RED BUG, *Lygidea mendax* Reut.—No reports received, and it was not known to exist in numbers sufficient to cause any damage.

APPLE SEED CHALCID, *Syntomaspis druparum* Boh.—Near Berwick some varieties of apples were found severely infested, it has also been observed in other localities. This insect seems to prefer the small, sweet varieties and is not of any great economic importance.

BROWN-TAIL MOTH, *Euproctis chrysorrhoea* L.—Since 1907 when this insect was first discovered in Nova Scotia an annual inspection has been maintained, as result of which winter webs were yearly collected until 1927-28 when none were found. There is every reason to believe that this one-time threatening pest is now eradicated from Nova Scotia.

EYE-SPOTTED BUDMOTH, *Spilonota ocellana* Schif.—There has been such a severe infestation of this moth in the Annapolis valley for the past few years that fruit growers have met with serious losses. In 1928 there has been a very decided improvement, and many warehouse managers are reporting the percentage of scarred fruit to be small. As comparatively few parasites were recovered this improved condition can probably be attributed to persistent spraying with nicotine.

WHITE-TRIANGLE LEAF ROLLER, *Cacoecia persicana* Fitch.—This new pest has been taken at so many points in the Annapolis valley that it is without doubt scattered over the entire fruit growing belt. Although no decided outbreaks have occurred this year it nevertheless is causing considerable injury in some localities by scarring the fruit. These scars are very similar to those caused by the eye-spotted budmoth.

GRAY-BANDED LEAF ROLLER, *Eulia mariana* Fern.—During the summer of 1928 this insect has further proven itself to be a pest of much importance to fruit growers in the Annapolis valley, and one on which more attention must be devoted in the future. In the few orchards found infested as much as 30 per cent. of the fruit on some varieties has been rendered unfit for market. Control measures so far undertaken have been more or less of a preliminary nature but to date have not been very promising.

GREEN BUD WORM, *Argyroploce variegana* Hbn.—This insect, which is one of our minor pests, has been less in evidence this year than in 1927.

CIGAR CASE BEARER, *Haploptilia fletcherella* Fern.—This insect is present in most orchards, and evidently on the increase. There was considerable defoliation in a few orchards near Berwick, Williamston and Middleton.

CODLING MOTH, *Carpocapsa pomonella* L.—Wormy apples due to codling moth have been more numerous this summer than for many years.

EUROPEAN APPLE SUCKER, *Psyllia mali* Schmid.—This new introduction has spread over the entire Annapolis valley, nymphs being found west to Annapolis Royal. Due to the prevalence of the fungous parasite attacking the insect in 1927, there were not the usual numbers of suckers recorded in Kings county this year. There is liable to be an increase in numbers in 1929, as the dry summer of 1928 has not been favorable to natural control. Scouting in New Brunswick revealed the fact that there was some increase of suckers in the infested area, but fortunately only very little spread to new territory.

EUROPEAN RED MITE, *Paratetranychus pilosus* C. & F.—Severe outbreaks of this orchard pest have occurred at many points. Oil sprays were used in the early spring by many growers, on the whole with good results. The mites did not appear to be particularly numerous during the early part of the summer, but a pronounced increase occurred during August and September. In September eggs were laid in large numbers on the fruit as well as on the limbs of the trees.

Tetranychus flavus Ewing.—This species of mite was found this year in rather large numbers on apple foliage at Annapolis Royal. This mite was identified by Dr. H. E. Ewing of the Bureau of Entomology, Washington, who states that it is a species of much economic importance in the Pacific Northwest and at one time was considered to be probably the second most important pest in the Hood River valley, Oregon. It is to be

hoped that this pest will not prove to be as troublesome as the European red mite.

FALL CANKER WORM, *Alsophila pometaria* Harr.—There were a few small local outbreaks of this insect in various parts of the Annapolis valley, usually in neglected orchards. It was not so prevalent as in 1927.

GREEN APPLE BUG, *Lygus communis* Knight.—For the past two years a pronounced increase of this destructive bug has occurred over the Valley. In most districts evidence of its work is to be found by punctured foliage or damaged fruit. A local outbreak occurred at Roundhill resulting in a reduced crop for some varieties.

GREEN FRUIT WORMS, various species.—These insects, considered as among our minor insect pests, were present in about the usual numbers.

EASTERN TENT CATERPILLAR, *Malacosoma americana* Fab.—Egg masses during the winter of 1927 were more in evidence than usual. Parasites attacking this insect were numerous during the summer. In order to obtain adults a considerable number of caterpillars were brought to the laboratory when nearly mature. This failed in its purpose, as only one emerged, the remainder being parasitized.

OYSTER SHELL SCALE, *Lepidosaphes ulmi* L.—A number of minute parasites were recovered from the winter scales. These parasites appeared to be sufficiently numerous to cause an appreciable control. In any event, oyster shell scales were less numerous than the previous year.

SERPENTINE LEAF MINER, *Nepticula pomivorella* Pack.—Numerous parasites were obtained from the hibernating scales. Although still numerous at Annapolis Royal and Lequille, there is a reduction in comparison with the past two or three years.

PLUM CURCULIO, *Conotrachelus nenuphar* Hbst.—This insect was prevalent at Annapolis Royal on plums.

TUSSOCK MOTHS—Early in the winter of 1927 egg masses were numerous. These masses are readily devoured by birds through the winter which seems to be an important source of control. At one apple orchard in Wolfville the larvae were quite conspicuous, but apart from this they were comparatively scarce in the Valley.

LEAF HOPPERS—Leaf hoppers, which have been abundant for the past two or three years, were less numerous during this present season.

APPLE AND THORN SKELETONIZER, *Simaethis pariana* Cl.—In "Report of Insects of the Year 1927 in Nova Scotia" published in this Society's report for last year, mention was made of *Allononyma vicarialis* Zell. An error was made in the identification of this species. It has since been determined as *Simaethis pariana* Cl. This is apparently the same species as described by Felt and Leonard in Cornell Extension Bulletin No. 86, 1924, as *Hemerophila pariana* Cl. This insect has two broods in Nova Scotia, and during the latter part of the summer again skeletonized apple foliage, more particularly in the neglected orchards in the western part of the Annapolis valley. Although not quite so destructive in this area as last season, there has evidently been a wider dissemination of the insect, and many specimens came through the mail to the laboratory for identification, from widely scattered points in Lunenbury, Hants and Kings counties.

THE SHOT HOLE BORER, *Scolytus rugulosus* Ratz.—This beetle has been reported from several localities, more particularly at Bridgetown and Lakeville. Upon examination at these places it was found that the trees were situated in low-lying portions of the orchards and indicated winter injury, probably due to the excessive moisture the previous year. As this borer rarely attacks vigorous trees it must be considered a secondary pest, which fact has always been more or less recognized.

Field Crop and Garden Insects

Carrot Rust Fly, *Psila rosae.*—This truck crop insect, which has been more or less troublesome for the past few years, was prevalent in 1928.

Wire Worms—No reports were received during the year that wireworms caused any damage to crops.

Cutworms—The cutworm population has been at a very low point, during the year. This condition was apparently quite general.

Slugs—This repulsive creature has been particularly troublesome throughout the season, especially in the small gardens.

Spring Tails—These insects were found literally swarming in a garden at Annapolis, and appeared to be feeding on the corn kernels which had been recently planted.

Corn Ear Worm, *Heliothis obsoleta.*—No reports were received indicating that this insect reached as far north as Nova Scotia this year.

Colorado Potato Beetle, *Leptinotarsa decemlineata* Say.—There was about the usual abundance of potato beetles during the year. In small gardens it was common for the old beetles to eat partially through the stems of tomato plants recently transplanted to the field, causing them to topple over.

Onion Maggot, *Hylemyia antiqua.*—The maggots were observed in both sets and seedlings at Annapolis.

Imported Cabbage Worm, *Pieris rapae.*—The cabbage foliage was badly damaged by the caterpillars.

Tarnished Plant Bug, *Lygus pratensis.*—This insect has been particularly abundant on many garden crops throughout the summer. It was also observed on flowering plants.

Zebra Caterpillar, *Ceramica picta* Harr.—Late in October these caterpillars were common in gardens. This may indicate that the insect will be more prevalent next year.

Miscellaneous

The Elm Sawfly, *Cimbex americana.*—A local outbreak of this sawfly occurred at Tremont, Kings county, where a few large ornamental elms were completely defoliated in September. For some time after defoliation the larvae kept dropping from the branches by the thousands and ascended the trees by crawling up the trunk. They refused all other vegetation in the vicinity and later died in immense numbers, apparently from starvation. At the laboratory attempts were made to feed the larvae on willow and birch, other mentioned host plants, but this food was refused.

INSECTS OF THE SEASON 1928 IN NEW BRUNSWICK

R. P. Gorham, G. P. Walker and L. J. Simpson, Dominion Entomological Laboratory, Fredericton, N.B.

Field Crop and Garden Insects

With the exception of a few species, field crop insects in general gave less trouble than usual during the summer of 1928 in New Brunswick.

A special effort to collect cutworms for rearing was made in the spring and in connection with this it was found that many were fungus-killed. Gardens almost completely escaped the usual cutworm injury, and, with two exceptions, cutworms were rare all summer.

BRONZE CUTWORM (*Nephelodes emmedonia* Cram.)—An outbreak of bronze cutworm occurred on the reclaimed salt marsh, known as the 'Tantramar marsh,' in Westmorland county in July. An area six miles long by four miles wide was affected and about 2,000 acres of grass land stripped. Moths were flying in numbers and ovipositing on July 28. Egg counts taken in October show that there was an average of 42 eggs per square foot on the marsh this past autumn. At Fredericton, the moths were taken in moderate numbers at the traplight from August 1 to September 21.

ARMYWORM (*Cirphis unipuncta* Haw.)—A small outbreak of the armyworm occurred on Pickett's marsh, St. John river, Kings county, in August. Several hundred acres were affected but no stripping occurred. Moths were found emerging on August 27. An October examination has shown about four caterpillars per square yard going into hibernation on this area. The reappearance of this insect is of interest because it occurs on an area stripped in 1914, when the last general outbreak occurred.

COLORADO POTATO BEETLE (*Leptinotarsa decemlineata* Say.)—The Colorado potato beetle suffered a food shortage in the autumn of 1927 through the general destruction of potato plants by blight in August. The plants over the whole province were killed just as the beetles of the summer generation began to emerge. They were forced to feed upon exposed tubers, tomato vines, etc. Field counts taken in October showed an average of two dead beetles on the ground per hill of potatoes. The spring emergence in 1928 began six days earlier than usual but the numbers of beetles were very small. Field counts on June 9 showed less than one beetle per four plants, where the average of other years has been three per plant. They were not abundant at any season and some small growers and gardeners did not find it necessary to spray for their control.

POTATO APHIDS.—Were abundant for the third successive year. Growers are beginning to believe that this insect causes direct loss of crop through its feeding aside from its potential injury through the transmission of disease.

POTATO FLEA BEETLE (*Epitrix cucumeris* Harr.)—Flea beetle injury was common along the St. John valley but rare along the northeastern coast of the province and through the Miramichi valley.

Crambus ruricolellus Zell.—The larvae of this insect injured corn seedlings on one farm in Sunbury county during late June, the first record of this insect causing injury to crops in the province.

EUROPEAN CORN BORER (*Pyrausta nubilalis* Hbn.)—The European corn borer was discovered on five farms in the St. John valley by the scouting crew in late summer. Most of the insects were in the pupal stage when found and some moths had already emerged. This is the first discovery of the corn borer in the Maritime Provinces.

EUROPEAN LEAF-ROLLER (*Cacoecia rosana* Fitch.)—This insect caused considerable injury to a variety of garden shrubs and ornamental plants in St. John city gardens during June and July. Bush honeysuckle, hydrangea, raspberry, currant, dahlia and paeony plants were chiefly injured. This is also a new insect in the province.

TARNISHED PLANT BUG (*Lygus pratensis* L.), and FOUR-LINED PLANT BUG (*Poecilocapsus lineatus* Fab.)—Both of these insects were troublesome in Fredericton gardens injuring asters, dahlias, hydrangea, weigelia and potatoes. Both species were more than usually abundant and troublesome.

Root maggots were somewhat less common than usual.

SEEDCORN MAGGOT (*Hylemyia cilicrura* Rond.)—The seedcorn maggot, usually troublesome to bean seedlings, was scarce in 1928.

CABBAGE MAGGOT (*Hylemyia brassicae* Bouche).—Cabbage maggot caused very little trouble to cabbage or cauliflower, but was reported from two districts as injurious to swede turnips.

ONION MAGGOT (*Hylemyia antiqua* Meig.)—Onion maggot was so scarce that no instance of injury was seen during the summer.

CARROT RUST FLY (*Psila rosae* Fab.)—The first generation of carrot rust fly caused little injury and the second generation was only injurious in a few districts.

Acrobasis comptoniella Hlst.—Sweet fern (*Myrica asplenifolia* L.), was generally infested with lepidopterous larvae in June. Specimens reared were identified as *Acrobasis comptoniella* Hlst.

EUROPEAN DUNG BEETLE (*Geotrupes stercorarius* L.).—The European dung beetle was found at Fredericton and at Scotch lake, places twenty miles apart, so is evidently well established in this region. This is a new insect in the province.

SLUGS—These creatures were common and troublesome in all parts of the province. Their eggs are very numerous in the soil this autumn.

FRUIT INSECTS

APPLE MAGGOT (*Rhagoletis pomonella* Walsh.)—Apple maggot is the major insect pest of the orchards of New Brunswick and has made its appearance, in varying degrees, in practically every section of the province where apples are grown. It has been noted this year seriously injuring crops of Yellow Transparent, Crimson Beauty, Duchess, Dudley, Wealthy, Wolfe River, Alexander, Baxter, Fameuse, McIntosh Red, Gideon, Bethel and various types of native or wild apples. It has reached serious proportions in several sections.

CIGAR CASE BEARER (*Haploptilia fletcherella* Fern.)—This insect was noted in outbreak form at French lake in Sunbury county. It was also noted as making its appearance at Burton, Sunbury county, and at Gagetown and McAlpines in Queens county.

APPLE APHID (*Aphis pomi* DeG.)—Apple aphis, although appearing in all orchards, was greatly reduced in numbers as compared with the season of 1927.

CODLING MOTH (*Carpocapsa pomonella* L.)—Codling moth has shown a slight increase in treated orchards and a comparatively heavy increase in small orchards that were allowed to go without treatment.

EYE-SPOTTED BUD MOTH (*Spilonota ocellana* Schiff.)—This insect has shown a decided increase generally, especially in sections where there are untreated orchards present.

GREEN FRUIT WORM (*Graptolitha antennata* Walk.)—The work of green fruit worm was noted as being of about average importance.

PLUM CURCULIO (*Conotrachelus nenuphar* Hbst.)—Plum curculio was present in serious outbreak form in the French lake section of Sunbury county. Its work was also noticed to a slight degree at Burton and Maugerville in Sunbury county, Gagetown in Queens county and at Springhill and Douglas in York county.

GREEN APPLE BUG (*Lygus communis* var. *novascotiensis* Knight.)—A very serious outbreak of green apple bug was noted at Shediac, Westmorland county. It was also present to a lesser degree along the St. John river valley in the counties of York, Sunbury and Queens.

APPLE LEAFHOPPER (*Empoasca mali* LeB.)—Heavy outbreaks of apple leafhopper were noted in the vicinities of Moncton and Shediac in Westmorland county and at Buctouche in Kent county.

EUROPEAN RED MITE (*Paratetranychus pilosus* C. & F.)—A number of individual trees near Shediac, Westmorland county, were noticed infested with European red mite.

Oyster Shell Scale (*Lepidosaphes ulmi* L.)—Oyster shell scale has increased to a marked degree in several orchards in Carleton, York and Sunbury counties. An appreciable quantity of the fruit in orchards at Springhill, York county, and Burton, Sunbury county, was heavily infested with the scales.

Pear Leaf Blister Mite (*Eriophyes pyri* Pagnst.)—Incipient outbreaks of pear leaf blister mite occurred at Gagetown and McAlpines in Queens county and Shediac in Westmorland county.

Eastern Tent Caterpillar (*Malacosoma americana* Fab.)—Throughout the St. John river valley, the eastern tent caterpillar was markedly more numerous than last year.

White-Marked Tussock (*Hemerocampa leucostigma* S. & A.)—White-marked tussock showed a slight increase over 1927 from Springhill, York county, to Gagetown, Queens county, along the St. John river.

Pear Slug (*Eriocampoides limacina* Retz.)—Several cherry and plum trees in the vicinity of Fredericton were infested with pear slug.

Yellow-Necked Caterpillar (*Datana ministra* Drury.)—Yellow-necked caterpillar appeared more prevalent than usual in the orchards of the St. John valley.

Red-Humped Caterpillar (*Schizura concinna* S. & A.)—A few individual clusters of red-humped caterpillar were noticed in Sunbury and York counties.

Fall Webworm (*Hyphantria cunea* Drury).—Fall webworm was somewhat more prevalent than usual in orchards in York, Sunbury and Queens counties along the St. John river and was also reported as numerous in the vicinity of Woodstock, Carleton county.

Fall Canker Worm (*Alsophila pometaria* Harr.)—Several egg masses of fall canker worm were taken at French lake, Sunbury county.

Buffalo Treehopper (*Ceresa bubalus* Fab.)—Observations of infestations of buffalo treehopper were noted at Burton, Sunbury county, and at Gagetown, Queens county.

Slugs—Considerable injury was caused by slugs to drop apples and to fruit on low-headed trees in all apple-growing sections where the branches were weighted down so that they touched the ground.

Forest and Shade Tree Insects

Larch Sawfly (*Nematus erichsoni* Hartig.)—In past seasons larch sawfly has been very abundant throughout New Brunswick, severely damaging larch stands by repeated defoliation. This past season, (1928), it almost completely disappeared. The cause of the sudden decrease is not known at the present time.

Larch Case Bearer (*Haploptilia laricella* Hbn.)—For the past few years the larch case bearer has been present in outbreak form and this season the infestation of this insect on larch was about average. The trees were severely damaged early in the season.

Felted Beech Coccus (*Cryptococcus fagi* Baernsp.)—The felted beech coccus was first discovered in New Brunswick in 1927 near Dorchester in Westmorland county and Albert in Albert county. In 1928 an extensive survey of these two counties showed the insect present in nearly all the beech areas. It is also reported abundant in beech stands on Prince Edward Island. This species has caused the death of a large percentage of the beech in Nova Scotia.

Spruce Gall Aphids (*Chermes* spp.)—There are several species of spruce gall aphids in New Brunswick. This season the infestations on white and red spruce were about the same as last year.

FALL WEBWORM (*Hyphantria cunea* Drury.)—Judging from the large number of webs noticed in different parts of the province this year, the fall webworm seems to be on the increase in New Brunswick.

WHITE-MARKED TUSSOCK (*Hemerocampa leucostigma* S. & A.)—White-marked tussock was again quite abundant and seems to be increasing. The last outbreak occurred in 1917.

EASTERN TENT CATERPILLAR (*Malacosoma americana* Fab.)—Large numbers of webs of eastern tent caterpillar were observed this summer. The adults were quite abundant about lights during the egg-laying period and numerous egg masses have been observed this fall. These features indicate that the insect will be quite abundant in 1929.

INSECTS OF THE SEASON 1928 IN QUEBEC

C. E. PETCH, DOMINION ENTOMOLOGICAL LABORATORY, HEMMINGFORD, QUE.

APPLE APHID (*Aphis pomi* DeG.)—A single outbreak of green apple aphid occurred at Mt. Johnson near Iberville, Que., whereas in 1927 there was a general occurrence of this pest in all the apple growing sections. This year a single application of a sodium polysulphide dust applied at the green tip stage killed almost 100 per cent. of the aphids.

CHERRY CASE-BEARER (*Haploptilia pruniella* Clem.)—The cherry case-bearer was the most common and easily the most destructive of the case-bearers to apple. The numbers were largely increased over previous years in several localities but it was especially numerous in Ville LaSalle. For the past several years it has been so destructive in Ville LaSalle that the tops of apple trees have been defoliated.

EYE-SPOTTED BUDMOTH (*Spilonota ocellana* Schiff.)—This budmoth was more numerous and more destructive to the fruit than in any previous season since the laboratory was established in 1912. The late varieties of apples had as much as 10 per cent. of the crop injured. It was especially troublesome at Valleyfield.

CODLING MOTH (*Carpocapsa pomonella* L.)—The codling moth has never been a very serious pest to apples over any considerable area in our experience. In the St. Hilaire district, however, the "side-worm" injury was very common in late varieties of apples, such as Fameuse and McIntosh.

APPLE CURCULIO (*Tachypterellus quadrigibbus* Say.)—In the Rougemont district the beetles attacked as much as 50 per cent of the apples but in other apple districts its injury was much less than in the several previous years.

ROUND-HEADED APPLE TREE BORER (*Saperda candida* Fab.)—A fairly complete survey of the apple orchards of the province resulted in an average infestation of 15 per cent. of the trees under 15 years of age. This figure denotes the economic importance of this insect and it may safely be said it is our most destructive insect to the apple tree.

EASTERN TENT CATERPILLAR (*Malacosoma americana* Fab.)—The tent caterpillar was more prevalent in southwestern Quebec than in any other season since the outbreak ending in 1914. Fortunately, the injury was not very severe since feeding was greatly retarded by continued rainfall.

APPLE MAGGOT (*Rhagoletis pomonella* Walsh.)—Spraying for the control of this insect has become very general in the province in the latter years and this practice has reduced the status of this pest from that of

first rank to a minor position. It was very destructive in unsprayed or poorly sprayed orchards this year.

CABBAGE MAGGOT (*Phorbia brassicae* Bouche.)—On the Island of Orleans and at Hemmingford 25 per cent. of the cabbage plants were killed by this insect.

JUNE BEETLE AND WHITE GRUBS (*Phyllophaga anxia* Lec.)—There were very large flights of June beetles every night during the last week of May and early June. They attacked oak, poplar, American elm and raspberry and caused very serious foliage injury in southwestern Quebec. The larvae were scarce in this area due to the 3-year life cycle of the pest. However, the white grubs of what is presumed to be the same species caused extreme injury to strawberries, potatoes and cucumbers in Two Mountains county.

POPLAR AND WILLOW BORER (*Cryptorhynchus lapathi* L.)—It was found very prevelently in Carolina poplar wherever it was used as an ornamental tree. In the trees examined the larval population often reached more than 50 per tree.

POPLAR BORER (*Saperda calcarata* Say.)—The larvae of this beetle were found in large numbers in poplar in several localities. Several of the trees observed had been killed by this insect.

MAPLE LEAF-CUTTER (*Paraclemensia acerifoliella* Fitch.)—In the sugar maple woods of southwestern Quebec a severe infestation of this insect occurred again this year. In many of the woods practically every leaf on every tree was affected. Similar injury has been observed for the past five years.

COLUMBINE BORER (*Papaipema purpurifascia* G. & R.)—Cultivated columbines in a garden at St. Hilaire were considerably injured by this borer by mid-July.

LARKSPUR LEAF MINER (*Phytomyza sp.*)—Larkspurs were ruined in Huntingdon county by this leaf miner. It has been studied here for the past two years. It was found that burning the canes and leaves of the larkspur, when the blossoming period was just over, killed the hibernating puparia and made spraying or dusting unnecessary.

INSECTS OF THE SEASON 1928 IN ONTARIO

W. A. ROSS, DOMINION ENTOMOLOGICAL LABORATORY, VINELAND STATION.

L. CAESAR, ONTARIO AGRICULTURAL COLLEGE, GUELPH, ONTARIO.

ORCHARD INSECTS

CODLING MOTH (*Carpocapsa pomonella* L.)—Codling moth injury was about "normal" this year.

SAN JOSE SCALE (*Aspidiotus perniciosus* Comst.)—This scale insect was again scarce and caused almost no damage.

OYSTER SHELL SCALE (*Lepidosaphes ulmi* Linn.)—There are indications that this species is becoming more troublesome than it has been for the past decade. Its increase may perhaps be due to the practice now common in most orchards of omitting a dormant spray of lime sulphur.

APPLE MAGGOT (*Rhagoletis pomonella* Walsh.)—If a special effort had not been made to control the apple maggot, the probabilities are that there would have been a more serious and widespread outbreak of the insect than that of 1927. In many orchards where the maggot sprays were omitted, practically all the fruit was infested and ruined, and it should be mentioned that in some of these orchards there was little or no noticeable injury in 1927.

APPLE APHIDS (*Aphis pomi* DeGeer, *Anuraphis roseus* Baker.)—The presence on apple and other fruit trees of exceptionally large numbers of ladybird beetles, particularly *Adalia bipunctata*, was no doubt one of the most important factors in preventing outbreaks of fruit aphids. Be that as it may, the apple aphids *Aphis pomi* and *Anuraphis roseus* were of little or no consequence this year.

THE BUD MOTH (*Spilonota ocellana* D. and S.)—In both sprayed and unsprayed orchards almost all over the province the bud moth was unusually numerous.

THE CIGAR CASE-BEARER (*Haploptilia fletcherella* Fern.)—This case-bearer was very conspicuous in every fruit district in the province, and partially defoliated many unsprayed or poorly-cared-for apple orchards.

EASTERN TENT CATERPILLAR (*Malacosoma americana* Fab.)—This caterpillar was again abundant in the same districts as last year. The main infestation was from Lake Huron to Toronto.

APPLE LEAF HOPPER (*Typhlocyba pomaria* McA.)—What would unquestionably have been an exceptionally severe outbreak of the leaf hopper *T. pomaria* in apple orchards, particularly in the Niagara district and Peel, Halton and Norfolk counties, was reduced to moderate proportions, chiefly we believe, by dryinid parasites. Examinations of adults collected by sweeping in a Vineland orchard gave the following percentages of dryinid parasitism: July 11—62.2%, September 13—48%.

APPLE RED BUG (*Lygidea mendax* Reut.)—An infestation of red bug in an apple orchard at Fenwick was reduced to insignificance by thoroughly drenching the trees with nicotine sulphate after the blossoms fell. In another orchard near Meaford the bug seriously deformed the fruit, but elsewhere it apparently was not more abundant than usual.

FRUIT-TREE LEAF-ROLLER (*Cacoecia argyrospila* Walker.)—Generally speaking, in the past, this insect has been destructive only in a comparatively small number of orchards in widely separated districts, but this year it was quite prevalent and caused conspicuous damage to apples in Huron, Norfolk, Durham and Northumberland counties.

CANKER WORMS (*Paleacrita vernata* Peck, *Alsophila pometaria* Harris)—No complaints of injury from either species were received.

PEAR PSYLLA (*Psyllia pyricola* Forst.)— This insect caused no appreciable injury in the pear growing sections of the province. As all pear orchards of any consequence were sprayed with oil, leaving us without a check, it is difficult to say to what extent freedom from injury was due to spraying. Late winter and early spring weather conditions were unquestionably responsible for a marked reduction in the spring brood "flies."

CHERRY FRUIT FLY (*Rhagoletis cingulata* Loew.)—Considerable loss was again caused by fruit fly maggots in orchards which were severely infested in 1927 and which did not receive the maggot sprays this year.

BLACK CHERRY APHIS (*Myzus cerasi* Fab.)—This species was of little importance in cherry orchards.

EUROPEAN RED MITE (*Paratetranychus pilosus* C. and F.)—While there was no serious outbreak of *P. pilosus*, characteristic mite injury was much in evidence in Niagara plum orchards which were not sprayed with oil. Injury was also noticed in some apple orchards.

ERIOPHYIDS.—The following species of free-living Eriophyids were present in noticeable numbers at Vineland this year: *Epitrimerus piri* Nalepa on pears, *Phyllocoptes fockeui* Nalepa on plums and *Phyllocoptes* sp. on black currants.

ORIENTAL PEACH MOTH (*Laspeyresia molesta* Busck.)—As anticipated, there was quite an extensive spread of the insect in the Niagara peninsula. The Entomological Branch scouts found it in all sections which

they inspected, and the probabilities are that it is now present in over fifty per cent. of our orchards. Early in the season severe twig injury was only too common, and all the indications were that the outbreak of peach moth would be much more intensive than it was last year. However, we are pleased to report that natural control factors came to the fruit grower's aid, and, in most orchards reduced the infestation to a very marked extent, particularly in the severely infested St. Davids district—e.g. in the Calvert orchard and St. Davids where the Elberta infestation in 1927 averaged 64 per cent., only 24.7 per cent. of the fruit was injured this year. The Fisher Elberta orchard at Queenston showed an increase of 7.17 per cent. (3.63 per cent in 1927 to 10.8 per cent. in 1928) and our observations indicate that there was a general increase along the Niagara river, but this was very small compared with what we anticipated. In the western part of the peninsula, our infestation records indicate that there was not much more than a trace of the moth—e.g. in the Orr orchard at Fruitland, the Elberta infestation dropped from 7.27 per cent. to 0.40 per cent.

Nothing in the way of an explanation of the decrease in peach moth injury will be attempted until we have had time to analyze carefully all our data and records on parasitism, weather conditions, etc. With what information we have on hand at the present time, it seems evident that while parasites undoubtedly played an important role, they were not wholly responsible for the reduction in the ravages of the insect. The average percentage of egg parasitism at St. Davids was approximately 18 and the percentages of larval parasitism in caterpillars taken from fruit and twigs were only 2 and 13 respectively.

Grape and Bush Fruit Insects

Rose Chafer (*Macrodactylus subspinosus* Fab.)—This species, generally speaking, was of minor importance, but it was sufficiently abundant at Ridgeville to necessitate the spraying of grapes.

Grape Berry Moth (*Polychrosis viteana* Clem.)—This pest was present in injurious numbers in several vineyards along the lake shore between Vineland Station and Beamsville, and also in at least two graperies near Virgil.

Grape Leaf Hopper (*Erythroneura comes* Say & *E. tricincta* Fitch.)—A minor outbreak of leaf hoppers occurred in several vineyards between Beamsville and the Niagara river. Where spraying was done according to the recommendations in the Ontario Spray Calendar, the insects were readily brought under control.

Raspberry Saw-Fly (*Monophadnoides rubi* Harr.)—This insect was present in outbreak form in several parts of the province, notably in the Niagara district from Stoney Creek to Peachland, and in Norfolk county at Simcoe. Badly infested plantations were almost completely defoliated by the larvae.

Red Spider (*Tetranychus telarius* L.)—Minor outbreaks of this pest occurred on raspberries at Vineland Station and Stoney Creek.

Stripped Tree Cricket (*Oecanthus nigricornis* Walk.)—Many complaints were received of injury to raspberries by this species.

Eulecanium corni—In two blackberry plantations at Ridgeville, the variety Eldorado was very heavily infested with this scale.

Cyclamen Mite (*Tarsonemus pallidus* Banks.)—In view of the discovery made this year by Dr. G. M. Darrow, U. S. Bureau of Plant Industry, that the cyclamen mite infests the strawberry and is apparently responsible for a very marked dwarfing and crinkling of the leaves, it is of interest to record here that this same mite was found in strawberry fields

at Jordan, Vineland, Hamilton, Burlington and Ottawa, infesting the following varieties: Vanguard, Parsons, Dr. Burril, Premier, Mastodon (fall bearing), and Forward (fall bearing). The most severe distortion and dwarfing of the foliage was noticed on Mastodon, Vanguard and Parsons. Experiments are now under way for the purpose of determing if the mite is wholly responsible for the foliage injury.

The cyclamen mite is negatively phototropic and consequently is found in greatest numbers within the young unfolded leaves. As Garman's observations on the behaviour of *Tarsonemus* in greenhouses indicate that moisture favors its development, the probabilities are that last summer's high humidity was very favorable for it, and that in dry seasons it will be of little consequence.

Vegetable Insects

Carrot Rust Fly (*Psila rosae* Fab.)—In 1926 and 1927 the carrot rust fly was very abundant and destructive over most of the Province. This year there were few complaints of injury from it.

Cabbage Maggot (*Phorbia brassicae* Bouche.)—The season was not specially favorable for this insect and no more than the usual number of inquiries regarding it were received.

Onion Maggot (*Hylemyia antiqua* Mgn.)—More complaints of injury from this insect than from the cabbage maggot were received. In a few districts the injury was rather severe.

White Grubs (*Phyllophaga spp.*)—There was apparently less injury than usual from these.

Wireworms (*Agriotes mancus* et al.)—Requests for control measures for wireworms were received from almost every part of the Province. In some instances correspondents stated that their fields had been under a short rotation for several years, but in spite of this were still heavily infested.

Grasshoppers—There have been no complaints of grasshopper damage.

Spinach Leaf-Miner (*Pegomyia hyoscyami* Panz.) — This insect caused but little damage though requests for control methods were received from Alliston and Cobourg.

Turnip Flea-Beetle (*Phyllotreta vittata* Fab.)—This species destroyed fields of young turnips in a few localities, thus necessitating replanting.

Onion Thrips (*Thrips tabaci* Lind.)—Although present in every onion plot examined, no noticeable damage was done by this thrips.

Cutworms—A smaller number of complaints than usual was received.

Slugs—Almost all over the Province slug injury was common. The same has been true for the last three years, doubtless as a result of the unusually wet seasons.

Millipedes—Like slugs these were rather more abundant than usual.

European Corn Borer (*Pyrausta nubilalis* Hbn.)—Discussed elsewhere in this report.

Mexican Bean Beetle (*Epilachna corrupta* Muls.)—Discussed elsewhere in this report.

Shade Tree and Bush Insects

Hemlock Looper (*Ellopia fiscellaria* Gn.)—This looper, which was reported last year as causing serious damage in the Muskoka district, was again abundant there.

Lilac Leaf-Miner (*Gracilaria syringella* Fab.)—This introduced pest

has now become common in most parts of the Province. It does not, however, seem to have been any more destructive than last year in localities where it has been present for several years.

Household Insects

Cluster Fly (*Pollenia rudis* Fab.)—On warm days early in the spring swarms of cluster flies appear on the windows in many homes and caused considerable alarm.

House Cricket (*Gryllus domesticus* L.)—In Toronto and to a less extent in Kitchener, there was an unusual outbreak of this cricket.

Ants—Several species of ants, including *Monomorium pharaonis* L., seemed to be very abundant, judging from the large number of inquiries received.

Clothes Moths, Carpet Beetles and Silverfish—As usual there were numerous requests for control measures for these pests.

White Flies (*Trialeurodes vaporariorum* Westw.)—This common greenhouse pest caused trouble in many private homes.

Hemispherical Scale (*Saissetia hemisphaerica* Targ.)—This was the most common scale insect sent in by housewives and seems to have caused much damage to ferns throughout a large part of the Province.

Miscellaneous Insects

Columbine Borer (*Papaipema purpurifascia* G. & R.)—This borer was, as last year, very common. Many persons claimed they would have to cease growing columbine unless a remedy was found for it.

Stalk Borer (*Papaipema cataphracta* Grt.)—Perhaps it was the fear that this borer might be the European Corn Borer that caused so many people to send it in. Be that as it may, numerous specimens were received from many parts of the Province.

Saw-Toothed Grain Beetle (*Oxyzaephilus surinamensis* L.)—This grain pest was sent in from a fairly large number of farms and mills and seemed to be the most common pest of stored grain and its products this year.

INSECTS OF THE SEASON 1928 IN MANITOBA

A. V. Mitchener, M.A.C., University of Manitoba, Winnipeg

Norman Criddle, Dominion Entomological Laboratory, Treesbank.

Field Crop Insects

Grasshoppers.—There was an increase of grasshoppers in sandy situations, the species involved being *Camnula, Melanoplus angustipennis, dawsoni, bivittatus, atlanis* and *femur-rubrum* named in the order of their abundance. Grasshoppers have been conspicuously scarce during the past few years.

Wireworms.—Very little damage was done to crops by wireworms during the season. Two reports of injury were received, one from Sifton on May 16 where wheat was being destroyed and the other from Franklin on June 14 where a field of barley was being damaged.

White Grubs (*Phyllophaga* spp.)—White grubs were destructive in grass lands but chiefly confined to sandy localities or river flats. There was an exceptionally heavy flight of beetles.

SUNFLOWER BEETLE (*Zygogramma exclamationis* Fab.)—The sunflower beetle species did some damage to cultivated sunflowers.

BEET WEBWORM (*Loxostege sticticalis* L.)—Although several reports of injury was received during the summer of 1927 including one from Portage la Prairie where hemp was badly attacked, no reports of the beet webworm occurring in injurious numbers were received in 1928.

CUTWORMS.—During the season of 1928 practically no damage was done to field crops by the usual species of cutworms, *Euxoa ochrogaster* Gn. and *Euxoa messoria* Harr. The striped cutworm, *Euxoa tessellata* Harr. was the most common species present in Western Manitoba in 1928.

BERTHA ARMYWORM (*Barathra configurata* Walk.)—The bertha armyworm increased in numbers in a spectacular way during the year. This is the first year that it has become of marked economic importance in Manitoba. Its chief activities were devoted to sweet clover but in addition to that plant it also infested flax, cabbage, turnips, beets, beans and various flowering plants. The insect was found rather generally over south-western Manitoba from Morden westward and north at least to Birtle. It was also injurious for the first time in North Dakota. In a number of instances whole fields of sweet clover were entirely denuded and many others suffered to a lesser extent. The insect showed a marked preference for sweet clover and on that account flax was much less infested. Pupae dug up in October proved to be perfectly healthy, thus indicating further trouble from the insect next year.

SALT-MARSH CATERPILLAR (*Estigmene acraea* Dru.)—The salt-marsh caterpillar was very plentiful especially on sweet clover, to which plant it did considerable injury.

HESSIAN FLY (*Phytophaga destructor* Say.)—No reports of injury by Hessian fly in any section of the province were received during the summer.

WHEAT STEM MAGGOT (*Meromyza americana* Fitch.)—Very little damage resulted from the work of the wheat stem maggot.

WHEAT STEM SAWFLY (*Cephus cinctus* Nort.)—Injury due to wheat stem sawfly has decreased during the past few years in Manitoba. This decrease is due among several factors to an increase in the percentage of durum wheats grown in the normally infested area. Farming practices which include a greater percentage of other crops than wheat in the rotation have also helped to reduce the damage. Sweet clover is one of these crops. The area of infestation in Manitoba includes that portion of the province south of the Riding Mountains and west of a line drawn approximately from Gladstone through Portage la Prairie and from there in a slightly easterly direction to the U. S. boundary. The only serious loss was to some spring wheat west of Brandon, running in a rather narrow strip to Oak Lake and thence southerly to Reston. The southern margin of the province was almost wholly free of the insect.

GARDEN INSECTS

RED TURNIP BEETLE (*Entomoscelis adonidis* Pallas.)—The red turnip beetles were reported on turnips, radishes and cabbage at Boggy Creek in the Duck Mountain Reserve on August 15th.

COLORADO POTATO BEETLE (*Leptinotarsa decemlineata* Say.)—The potato beetle has increased in numbers again after its temporary relative scarcity. It is widespread throughout the cultivated areas of the province and potato growers find it necessary to practise control measures each year. Arsenate of lime is gradually replacing paris green as an insecticide for the control of this insect although not as rapidly as it should.

PEPPER GRASS BEETLE (*Galeruca externa* Say.)—The pepper grass beetle was very numerous and it did some damage to seedling cabbage, radish and turnip. It also attacked various garden Cruciferae.

ROSE CURCULIO (*Rhynchites bicolor* Fab.)—The rose curculio was very destructive to rose buds and blossoms.

CUTWORMS—Cutworms were relatively scarce, there being fewer in 1928 than for several previous seasons. The last outbreak which was at its peak in 1926 has now disappeared.

COLUMBINE BORER (*Papaipema purpurifascia* G. & R.)—The columbine borer was a pest of considerable importance to garden columbines.

WESTERN WHITE BUTTERFLY (*Pieris occidentalis* Reak.)—The western white butterfly was very abundant in western Manitoba. Contrary to expectations the larvae confined their attentions to wild and ornamental *Cruciferae.*

IMPORTED CABBAGE WORM (*Pieris rapae* L.)—Imported cabbage worm was extremely abundant, covering almost the entire cultivated area of the province. Cabbages when not taken care of were severely injured.

ONION MAGGOT (*Hylemyia antiqua* Meig.)—The onion maggot is an insect which seems to be increasing slightly in destructiveness in gardens. Reports of injury were received from Isabella, Neepawa, Macgregor, Carberry, Carman, Plumas and Elphinstone. Reports were also received during the early season of injury during 1927 at Newdale, Bayton, Keyes, and Mile 42, The Pas.

CABBAGE MAGGOT (*Hylemyia brassicae* Bouche.)—Very little damage was done by the cabbage maggot in 1928.

FOREST AND SHADE TREE INSECTS

OAK LACE BUG (*Corythucha arcuata* Say.)—The oak lace bug was a pest of considerable magnitude on oak leaves.

APHIDS.—Two species of aphids seemed numerous during the summer. One of these attacked box-elder (*Acer negundo*) and the other elm (*Ulmus* sp.). The latter species seemed particularly abundant especially in the Winnipeg area.

PINE NEEDLE SCALE (*Chionaspis pinifoliae* Fitch.)—Reports of injury to spruce by the pine needle scale were received from Winnipeg, Bird's Hill, Virden and Rossburn. This insect is widespread in its distribution in Manitoba and is responsible for much injury to spruce.

WESTERN WILLOW LEAF BEETLE (*Galerucella decora* Say.)—In 1927 the willow leaf beetle was very widespread and destructive to willow and poplar especially in Southern Manitoba. Foliage on immense tracts of bush was injured so badly from the larvae that it turned brown. In 1928 injury was again widespread throughout much of the province.

FALL CANKER WORM (*Alsophila pometaria* Harr.)—The fall canker worm is on the upward swing. Damage to shade belts is expected next spring.

LIME TREE LOOPER (*Erannis tiliaria* Harr.)—An extraordinary local outbreak of the lime tree looper took place in the Brandon Hills northwest of Rounthwaite. Every oak in about a square mile was defoliated and the larvae also had attacked Manitoba maple, cherry, *Viburnum,* ash, *Amelanchier* and various other shrubs. A visit to the area in Octoer revealed many female moths upon the trees and a great many eggs hidden beneath the bark.

FIR SAWFLY (*Neodiprion abietis* Harr.)— The fir sawfly probably attained its high point of destructiveness during the present year. It was met with in nearly every part of the province and did considerable damage to spruce shade belts. It also did much harm to balsams at Victoria Beach.

SPRUCE SAWFLY (*Pachynematus ochreatus* Harringt.)—The spruce sawfly seems to be increasing. It seriously injures spruce by eating the needles. It is easily killed with arsenicals. It was reported from Basswood, Inwood and Winnipeg and believed to be the insect attacking spruce at other places.

HOUSEHOLD INSECTS

GERMAN COCKROACH (*Blatella germanica* L.)—The German cockroach occurs in apartments, restaurants, institutional kitchens, etc. During the season its abundance was about normal.

BEDBUG (*Cimex lectularius* L.)—More requests for information concerning the control of the bedbug were received than for any other single insect. They are widely distributed and cause much annoyance and discomfort. An efficient and convenient remedy for the control of this insect is highly desired.

WHITE FLY.—The white fly is a common insect on house plants and its abundance remains more or less constant each year.

MOSQUITOES.—The outstanding entomological event of the year was the very extensive and prolonged mosquito outbreak. Mosquitoes had been fairly numerous in 1927 and preparations had been made in Winnipeg to meet an expected outbreak in 1928. Standing water was filmed with oil until near the end of June and very few mosquitoes were noticed up until that time. Funds for the continuance of the campaign of control failed at that time and by July 1 an enormous population of mosquitoes had emerged. All through July and up until about the beginning of the second week of August mosquitoes made life outside in parks, on golf courses, etc., almost impossible. The season in eastern Manitoba will long be remembered for its mosquito population.

ANTS.—Second only to bedbugs was the number of inquiries concerning the control of ants. These were received mostly from Winnipeg and vicinity. Beginning May 15 and continuing steadily until August 15 inquiries were received asking how ants could be controlled. Some produced hills in the yards, others made small holes in the lawns, and others invaded the houses. A number complained of ants found on poeny buds. Ants seem to be increasing as a pest each year.

SMALL FRUIT INSECTS

MEALY PLUM APHID (*Hyalopterus arundinis* Fab.)—The mealy plum aphid developed very rapidly on native cultivated plums in the orchard at M. A. C., until July 21 when it suddenly disappeared almost entirely due probably to a local hail storm. It is a serious pest of plums.

CURRANT APHID (*Myzus ribis* L.)—Currant aphids occurs annually on red and white currants but was rather less common last year than usual due no doubt to much rain during early summer.

PLUM FLEA BEETLE (*Disonycha davisi* Shaef.)—The plum flea beetle originally lived on wild sand cherry (*Prunus pumila*) but recently spread to cultivated plum and cherry. It was found both at Brandon and Morden.

UGLY-NEST CATERPILLAR (*Cacoecia cerasivorana* Fitch.)—The ugly nest caterpillar was extremely abundant on choke cherry but not otherwise of importance.

CURRANT FRUIT FLY (*Epochra canadensis* Loew.)—The currant fruit fly is an annual pest of red, white and black currants. Unsprayed fruit showed heavy infestation in 1928 when as much as 50% of the fruit was rendered useless in some currant patches. Reports were received from Elgin, Roseisle, Isabella and Winnipeg and vicinity.

IMPORTED CURRANT WORM (*Pteronidea ribesii* Scop.)—About the usual damage was experienced from imported currant worm during the season. Definite records were obtained from Warrenton, McAuley, Starbuck and Grandview.

THE WEATHER 1928

	April	May	June	July	Aug.	Sept.
Average rainfall in inches for the month	.50	1.69	5.83	5.02	1.40	.38
Average hours of sunshine for the month	225.3	299.4	235.6	251.8	290.0	199.2
Average mean temperature for the month in F. degrees	33.0	55.2	57.6	65.7	61.9	51.6
Average maximum temperature for the month in F. degrees	74.0	96.2	84.5	89.0	91.6	85.5
Average minimum temperature for the month in F. degrees	3.3	23.7	31.8	43.8	32.2	23.5

The above data for rainfall, maximum and minimum temperatures were obtained from records kindly submitted by observers at Morden, Treesbank, Brandon and Winnipeg. Those for sunshine and mean temperature are from Morden, Brandon and Winnipeg. In each case the records of these stations are averaged.

INSECTS OF THE SEASON 1928 IN SASKATCHEWAN

ELLIS MCMILLAN, DOMINION ENTOMOLOGICAL LABORATORY,
SASKATOON, SASK.

FIELD CROP AND GARDEN INSECTS

The variety of pests abundant in 1928 was notably small and the total damage was even lower than that recorded for 1927, which was the lowest for the past several years. There were no outstanding outbreaks of field crop insects, aside from the continuation of the serious and widespread damage by the bertha armyworm (*Barathra configurata,* Wlk.) in western Saskatchewan, where it was even more abundant than in the previous year.

In the point of losses caused, it is deemed that the perennial pest, the wireworm, was the chief insect species of the year, although it was not as serious as in 1927. The total estimated damage for the province as a whole caused by wireworms was one and one-half per cent.*

THE WHEAT STEM SAWFLY (*Cephus cinctus* Nort.) which caused such severe damage in 1926 has decreased each season since, and was at a low ebb in 1928. Estimated damage by this pest averaged two and one-half per cent. for the province at large.

CUTWORMS (*Euxoa ochrogaster* Gn. and allies) caused considerable trouble in gardens generally and some damage to field crops, the rate of injury being increased by the early hatching and the very dry conditions of May. The pale western cutworm (*Porosagrotis orthogonia* Morr) apparently was scarce in most districts, but, contrary to our expectation following the very wet season in 1927, appreciable damage was again reported in the Milestone district where the infestation was newly established the preceding season. Grasshoppers† (chiefly *Melanoplus atlanis* Riley) were abundant in an area of light soil and in many abandoned fields near Marengo (west-central Saskatchewan) and poisoning had to be resorted to

*The methods and basis used in obtaining these insect estimates will be found in Scientific Agriculture II: 373-390, King, K. M.

†Grateful acknowledgement for the hearty co-operation of the Saskatchewan Department of Agriculture re damage estimates and information concerning grasshoppers is hereby given.

The Colorado potato beetle (*Leptinotarsa decimlineata* Say) was more abundant than ever before in north-central Saskatchewan, economic infestations being common as far north as Shellbrook, near Prince Albert. The estimated damage by this pest for the province as a whole was two and one-half per cent. Several reports were received in the early spring of the abundance of tipulid larvae but no damage was recorded. The red turnip beetle (*Entomoscelis adonidis* Pall.) and the beet webworm (*Loxostege sticticalis* L.) were conspicuous by their absence. Currant pests were present in about the same numbers.

WIREWORMS.—A number of factors were observed to enter into the heavy rate of damage occasioned by wireworms this spring. Of prime importance was the use of much poor or unreliable seed (resulting from conditions of last fall), the effect of the wireworm activity being of course greatly augmented where the stand was already poor. May and early June were generally dry with high winds and the seed was put in exceptionally deeply; in spite of this germination was very slow and uneven, especially in spring ploughing until the June rains fell. There was, however, sufficient moisture at the seeding depths with existing temperatures, to permit full wireworm activity on the semi-dormant seed, which activity was continued late in the season and at high soil level as a result of the excellent rains of June and July. In the poplar belt, particularly, soil deficiencies and a root-rot found almost exclusively after summer-fallow, decreased plant resistence to injury; the effect of the root-rot was also confused with wireworm damage where few or no wireworms were present.

BERTHA CUTWORM (*Barathra configurata* Wlk.)—There was a very severe outbreak of the bertha cutworm during August and September. In Saskatchewan the area of infestation extended from the Saskatoon district in a broad band west to the Alberta boundary. In this area the infestation was apparently the heaviest ever recorded. Many large fields of sweet clover grown for seed purposes were completely ruined, while serious losses were recorded on cabbage and flax. This pest was also in outbreak form in Manitoba, Alberta, British Columbia, North Dakota and in Montana. There appears to be no question but that this pest is steadily increasing in importance each year, although the present outbreak may be somewhat exceptional in severity due to a succession of favourable years.

WHEAT STEM SAWFLY (*Cephus cinctus* Nort.)—The wheat stem sawfly was reported only from a few points as causing severe damage in 1928 and is probably now at its low level of infestation. "Whiteheads," i.e. heads of wheat largely or completely sterile, evidently due solely to the work of the sawfly grub, were encountered this year. In plants so affected the grubs were working high up in the stems and the head with the terminal section of the stem could be pulled out easily, evidently having been ringed just above the last node. *Meromyza* was not present.

CUTWORMS.—Cutworms were of very little importance in field crops, although severe damage to gardens was reported from many localities. Cutworm census work at Saskatoon early in June showed an average population of 2,000 per acre on a number of farms.

GRASSHOPPERS.—Reports during the year indicated that grasshoppers caused damage only in a few districts, but in all cases nymphs of the economically important species were few in number. However, since a severe outreak is reported from the United States, south of Saskatchewan, it is an interesting condition to observe since the last great outbreak spread into this province from the south and south-east.

APHIDS.—Most of our common aphids seemed to be very abundant, including the currant aphid and an aphid attacking Delphinium.

Beet Webworm (*Loxostege sticticalis* L.)—Despite the presence of great numbers of moths of the webworm, no outbreaks occurred.

Hessian Fly (*Phytophaga destructor* Say.)—One or two reports of Hessian fly were received, but evidently it was not as abundant as in 1927. However, severe damage was reported from one district in north-eastern Saskatchewan.

Currant Fruit Fly (*Epochra canadensis* Loew.)—The currant fruit fly was again quite troublesome.

Tortricid Leaf Rollers.—Larvae of several species of tortricids affecting strawberries and cherries were very abundant.

Rusty Tussock Moth (*Notolophus antiqua* L.)—A severe but very localized infestation of the rusty tussock moth occurred in Saskatoon. The chief damage was done to a hedge of pigmy caragana, although apple, rose and a climbing vine were also attacked. Interestingly enough, a hedge of common caragana adjoining the other was not damaged.

INSECTS OF THE SEASON 1928 IN NORTHERN ALBERTA

E. H. Strickland, University of Alberta, Edmonton, Alberta

Following an exceptionally hot period during the latter part of May the Summer of 1928 was abnormally cold and cloudy throughout June. Rainfall was, however, below the average. These conditions appear to have had a markedly detrimental effect upon insect populations and the northern part of Alberta suffered very little from pests of all kinds.

Wheat Stem Sawfly (*Cephus cinctus*) damage was held to a minimum. Larvae, presumably of this species, were taken during August in the stems of Brome grass in the Peace River District. Climatic conditions here are very similar to those obtaining over the area in which the greatest damage occurs in the three prairie provinces, but no transference to wheat has been recorded throughout the district.

Wireworm (*Ludius aeripennis*) damage was not heavy anywhere except in the Peace River District. Here, the month of June was warmer than around Edmonton and heavy losses were sustained in many fields that have been under the plough for upwards of twelve years. The most severe losses occurred in wheat seeded on old fields that have recently been broken from timothy sod. There were few losses recorded in wheat following brome sod. Pastured brome appeared to become more heavily infested than did that which had been regularly cut for hay. In this connection we have observed that the adult beetles collect under droppings, particularly those of cattle, beneath which the soil often remains cool and moist throughout the month of June.

Around Edmonton June was so cold that the beetles never laid eggs (we had about 300 individuals under observation in different types of soil) at a greater depth than ¾″ from the surface. The more usual depth is 5″. It is improbable that many of these shallowly deposited eggs hatched.

The outbreak of Forest Tent Caterpillars (*Malacosoma disstria*) is rapidly subsiding throughout the western half of Northern Alberta. It has spread to the eastern half where complete defoliation of aspens occurred over a large area. Judging from the number of egg-rings that have been sent in for determination, and from the fact that many twigs bore two or three of these rings, it would appear that a severe recurrence of this outbreak is to be expected in the eastern part of the province in 1929.

CABBAGE MAGGOTS (*Phorbia brassicae*) were exceptionally abundant. In gardens the dry spring necessitated frequent waterings and this greatly reduced the effectiveness of the corrosive sublimate treatment which is now widely employed for their control. From enquiries, it would appear that this insect has not yet reached the Peace River District.

THE BERTHA ARMY WORM (*Barathra configurata*) continues to hold a prominent place as a pest of sweet clover and various truck crops. Since its first appearance in destructive numbers around Edmonton in 1922 this insect has maintained a numerical ascendancy during seasons of widely varying climatic conditions and in widely scattered localities. This does not augur well for its subsidence by natural means. We are still unable to account for the remarkable increase in its mean of abundance that has occurred during the last six years. Though the adults have been long known to collectors in this province they were, formerly, considered to be somewhat rare insects.

THE POTATO BEETLE (*L. decemlineata*), apparently due to early snows in the fall of 1927, was present in destructive numbers as far north as Edmonton in 1928. Records of its northernmost occurrence fluctuated from year to year between Edmonton and districts of about 160 miles to the south. It would appear, however, that a few manage to survive, nearly every winter, near the northernmost boundary of its occurrence since it is improbable that the adults migrate over many miles prior to egg-laying.

Following a very severe outbreak of Mosquitoes (*Aedes Spp.*) in 1927 annoyance from these pests was negligible in 1928. The snow thawed rapidly in the spring and intensely hot weather in May rapidly dried up temporary collections of water at a time when they contained many immature larvae. This condition contrasted markedly with the wet cool spring of 1927.

ANTS (chiefly *Formica fusca*) rendering lawns unsightly, or entering houses, have been the subject of much complaint. Where the nests could be readily located calcium cyanide has proved to be the most satisfactory method of control.

Very few hotels in Alberta appear to be infested with bedbugs (*Cimex lectularius*) but private (and frequently anonymous) requests for information regarding their control have been more numerous than usual.

Complaints of the entrance of Dermestids (*Dermestes lardarius*) into houses always follow an outbreak of the Forest Tent Caterpillar. This, we believe, is due to the fact that the larvae of the latter pupate in large numbers under window-sills. Many pupae die and attract the beetles for oviposition. The young larvae gain entrance to the house through the window screens.

INSECTS OF THE SEASON 1928 IN ALBERTA

H. L. SEAMANS, DOMINION ENTOMOLOGICAL LABORATORY,
LETHBRIDGE, ALBERTA

Alberta was unusually free from insect outbreaks in 1928. The season was very favorable, producing the biggest crop in the history of the province. As a result, insect injuries were not so noticeable and some pests may have been present which were not reported.

BERTHA ARMYWORM (*Barathra configurata* Wlk.)—The most widespread outbreak in Alberta was that of the bertha armyworm. This insect has been increasing gradually for the last five years and this season it

covered the greater part of the province south of Edmonton. The moth flight during June and July was the heaviest ever recorded.

Larvae began to appear in alfalfa and sweet clover fields about the first of August. Many hundreds of acres of these crops were entirely stripped of seed and some were even ruined for hay. It also destroyed some fields of flax while gardens were stripped. Cabbages and potatoes suffered the most but no garden truck or flowers went untouched. Fortunately for the province this insect does not attack wheat or oats.

The losses might have been more severe had not a brief wet period during the last of August apparently favoured disease amongst the larvae. This was not very marked at first but within ten days practically all the larvae had died. Laboratory rearings were all destroyed by the same disease which was apparently present on the plant material supplied for food.

RED-BACKED CUTWORM (*Euxoa ochrogaster* Gn.)—Early in the spring a small outbreak of red-backed cutworm appeared in the irrigation districts of the extreme southern portion of Alberta. Sugar beets suffered the heaviest loss though a few fields of wheat were damaged. The use of poisoned bait soon controlled the outbreak in individual fields.

The majority of the destroyed acreage was reseeded to sugar beets after the application of the bait and no further loss was sustained. While this outbreak was not very extensive, it is the first definite outbreak of red-backed cutworm that Alberta has had for several years and may be the beginning of a general increase.

ARMY CUTWORM (*Chorizagrotis auxiliaris* Grt.)—It may be of interest to the members of the Entomological Society of Ontario to know that the moths and larvae of the army cutworm were exceedingly scarce in Alberta this season. This corroborates the statement made a year ago in connection with the paper which was presented regarding the forecasting of outbreaks of this species. Conditions in the season of 1928 indicate that there will be no outbreak in southern Alberta this coming season.

PALE WESTERN CUTWORM (*Porosagrotis orthogonia* Morr.)—The pale western cutworm has been scarce during the last five years but the weather data indicates an increase in 1929, though it will not reach widespread outbreak proportions. This is further borne out by the moth collections made this fall.

WHEAT STEM SAWFLY (*Cephus cinctus* Nort.)—This insect has not spread any great distance in Alberta during the last five years but is well established over half of the area south of Edmonton. Due to favorable weather conditions the damage this season was very light. The insect is present in sufficient numbers to cause serious losses the first dry season that occurs.

WIREWORMS.—Several species of wireworms were present in wheat fields this season. The early loss was sufficient to cause some worry on the part of the farmers. The favorable weather in June brought on much of the injured wheat and caused the rest to stook more heavily so that the losses were not noticeable when the grain was harvested.

OAT THRIPS (*Frankliniella tritici* Fitch.)—The oat thrips caused an average loss of ten per cent. throughout the province. All late seeded fields were heavily damaged. The very dry May frightened many of the farmers and stopped their seeding of prepared land. With the coming of the rains in June much of this land was seeded to oats, making them later than usual and more subject to thrips attack.

GRASSHOPPERS.—The grasshopper population of Alberta is still below normal. This has been the case over since the widespread campaign of 1922 and 1923.

INSECTS OF THE SEASON 1928 IN BRITISH COLUMBIA

ERIC HEARLE, DOMINION ENTOMOLOGICAL LABORATORY,
KAMLOOPS, BRITISH COLUMBIA

Messrs. Buckell, Downes, Glendenning, Hopping and Ruhman very kindly placed their seasonal notes, and those of their assistants, at the writer's disposal. This report is largely a compilation from these.

Several somewhat wet seasons have been experienced in the interior districts of the province, and the snowfall in the winter of 1927 was abnormally heavy, followed by a wet spring. These conditions have resulted in a marked effect on the abundance of certain insects. Biting flies, especially mosquitoes and black-flies, have been unusually numerous, and garden slugs have increased in some districts to such an extent that they have caused considerable damage. Grasshoppers and ticks, on the other hand, have been adversely affected in most sections. In the Lower Fraser valley less than normal precipitation has occurred.

ORCHARD INSECTS

CODLING MOTH (*Carpocapsa pomonella* L.)—In general this insect is too scarce in most apple growing districts to cause much damage. It has, however, increased considerably in the Kelowna district.

WOOLLY APPLE APHID (*Eriosoma lanigera* Hausman)—This insect has been very prevalent in many apple growing sections in British Columbia. Owing to its relationship to the spread of perennial canker it is one of the most serious pests to the fruit industry. Mr. E. P. Venables is undertaking a detailed investigation of the life-history and control methods.

FOREST TENT CATERPILLAR (*Malacosoma disstria erosa* Stretch)—A severe infestation on apple trees occurred in the Comox district.

YELLOW NECKED CATERPILLAR (*Datana ministra* Dru.)—This defoliator occurred in apple orchards in the Vernon district in greater numbers than have been noted for many years.

LESSER APPLE WORM (*Laspeyresia prunivora* Walsh)—Severe damage to fruit was caused by this insect in some sections of the Okanagan Valley. It was especially troublesome where cover crops were grown.

EYE SPOTTED BUD MOTH (*Spilonota ocellana* Schiff.)—This bud moth was very prevalent in orchards in the Vernon district.

GREEN APPLE APHID (*Aphis pomi* DeG.)—Heavy infestations of the Green Apple Aphid occurred in orchards in the Okanagan Valley. Young trees were especially badly affected.

APHIDS.—All species of aphids were reported as being abnormally scarce in the Lower Mainland.

SHOT HOLE BORER (*Anisandrus dispar* Fabr.)—This beetle caused more damage than usual in the Lower Fraser Valley.

RED SPIDER MITE (*Tetranychus bimaculatus* Harvey)—Severe infestation by this mite occurred on the foliage of prunes and plums in the Okanagan Valley.

PEAR SLUG (*Caliroa cerasi* L.)—This insect was reported as being unusually abundant from a number of different points in the province, including the Lower Mainland Okanagan Valley and Nelson district.

WESTERN CHERRY FRUIT WORM (*Grapholitha packardi* Zell.)—This native insect has become a serious pest on cherries in the Victoria district, and occasioned considerable losses during the present season.

BLACK BODIED CHERRY FRUIT FLY (*Rhagoletis fausta* O.S.)—This fruit fly is increasing in the Kootenay Lake district at Boswell and Wynndell, and if unchecked, may prove a serious pest to cherry growers.

Black Cherry Aphid (*Myzus cerasi* Fabr.)—This aphid was less numerous than usual in the Lower Fraser Valley, but is doing increasing damage on sweet cherries in the Kootenay Lake and Penticton districts.

Peach Twig Borer (*Anarsia lineatella* Zell.)—Considerable trouble was experienced in the Southern Okanagan from this insect.

Small Fruit Insects

Strawberry Root Weevil (*Brachyrhinus ovatus* L.)—This serious pest of the coastal small fruit districts has also been troublesome in the Kootenays during the past few years. In the latter district it did less damage than usual in 1928.

Western Strawberry Leaf Roller (*Anacampsis fragariella* Busck) —Damage from this insect occurred in the Nelson district.

Raspberry Cane Borer (*Phorbia rubivora* Coq.)—A serious infestation of this borer occurred in loganberry plantations in the small fruit sections of Vancouver Island.

Raspberry Byturus (*Byturus unicolor* Say)—Loganberries were infested with this beetle near Vancouver.

Imported Currant Worm (*Pteronidea ribesii* Scop.)—Large numbers of this insect occurred on currant bushes in the Lower Fraser Valley. It has been scarce for some years.

Currant Fruit Fly (*Epochra canadensis* Loew)—This fly occurred in average numbers on the Lower Mainland.

Gooseberry Sawfly (*Diphadnus appendiculatus* Hartig)—This insect was more abundant than usual in the Lower Fraser Valley.

Hop Aphid (*Phorodon humuli* Schrank)—Average infestations of this insect are reported from the Lower Fraser Valley.

Hop Flea Beetle (*Psylliodes punctulata* Melsh.)—This beetle occurred in average numbers in the Lower Mainland hop districts.

Field and Truck Crop Insects

Grasshoppers.—Due to adverse weather conditions in the spring and early summer, grasshoppers were not troublesome over the greater part of British Columbia, and were numerous only in a few localized areas.

Roadside Grasshopper (*Camnula pellucida* Scudder)—Heavy infestations of this species occurred in limited areas of the Chilcotin and Nicola Valleys; but in spite of the abnormally large numbers, injury caused by them does not appear to have been very extensive.

Cutworm Outbreaks.—Several severe cutworm outbreaks occurred in the province. The most extensive covering a wide area in the East Kootenays, and being most severe in the Cranbrook and Invermere districts. The species involved was the Bertha Cutworm (*Barathra configurata* Walker). Damage was also caused by this species in the vicinity of Kaslo and Summerland. A number of field and truck crops were attacked. Mortality from disease was very high among larvae from the Cranbrook outbreak.

Another outbreak of this species occurred in the Vavenby district of the North Thompson Valley. Leguminous plants mainly suffered, but a wide variety of other plants and shrubs were also attacked.

A severe infestation of the Olive Green Cutworm (*Heliophobus procinta* Grote) occurred in the Northern and Western sections of Vancouver Island and caused very serious damage. Clover, Oats, and couch grass were mainly affected. The last outbreak of this species is reported as having occurred about twenty years ago.

In the Lower Fraser Valley cutworms were much less numerous than usual.

WIREWORMS.—Severe infestations of wireworms have occurred in truck crops, especially in the Kelowna and Grand Forks districts. Damage to tobacco plots have been reported from the Okanagan Valley.

WHEAT MIDGE (*Thecodiplosis mosellana* Gehin)—This species was abundant and caused damage in the Lower Fraser Valley.

WHEAT STEM MAGGOT (*Meromyza americana* Fitch)—A small outbreak of this maggot occurred in the Enderby district. It has rarely been reported as destructive in British Columbia.

COLORADO POTATO BEETLE (*Leptinotarsa decemlineata* Say)—This beetle occurs in two areas in the South Eastern portion of this province, covering approximately six hundred square miles. It is particularly severe in the Cranbrook area. No further ground has been gained by it during the present season as two small fresh outbreaks outside the above areas have been absolutely eradicated, thanks largely to the energetic work of Mr. A. A. Dennys.

RED TURNIP BEETLE (*Entomoscelis adonidis* Pallas)—This beetle is troublesome on cruciferous crops in Central British Columbia in the Bulkley and Peace districts.

IMPORTED CABBAGE WORM (*Pieris rapae* L.)—The cabbage worm was very troublesome in many sections of the province. It was numerous again in the Lower Fraser Valley after being scarce in 1927.

CABBAGE FLEA BEETLE (*Phyllotreta albionica* Lec.)—A large percentage of the cruciferous crops in the Lower Mainland and parts of Vancouver Island were affected by this beetle. It was not more abundant than usual, however.

CABBAGE MAGGOT (*Phorbia brassicae* Bouche)—This insect occurred in less than normal numbers in the Lower Fraser Valley.

CABBAGE APHID (*Brevicoryne brassicae* L.)—Together with other aphids this species was unusually scarce in the Lower Mainland.

ONION MAGGOT (*Hylemyia antiqua* Meig.)—More trouble than usual was experienced from the Onion Maggot in the Upper Okanagan Valley, the greatest damage being caused in the Kelowna district. The wet autumn of 1927 was apparently favorable and resulted in the increase during the present season.

PARSNIP WEBWORM (*Depressaria heracliana* DeG.)—Some damage was caused by this insect in gardens at Victoria.

PEA APHID (*Illinoia pisi* Kaltenbach)—This aphid was unusually scarce in the Lower Fraser Valley.

GARDEN SLUGS (*Argiolimax agrostis* L.)—Slugs were unusually abundant in the Lower Fraser Valley and caused serious damage to field crops, beans, lettuce and other garden produce. Reports were also received of damage to gardens in the interior Wet Belt.

FOREST AND SHADE TREE INSECTS

SATIN MOTH (*Stilpnotia salicis* L.)—A very serious infestation of this moth occurred throughout the Lower Fraser Valley and East Coast of Vancouver Island. Severe defoliation was caused on cottonwood, poplars, willows and aspens—in many cases extensive stands of trees were completely stripped.

FALL WEBWORM (*Hyphantria cunea* Dru.)—The disfiguring webs of this caterpillar have been unusually abundant this year in the Lower Fraser Valley.

Coast Tent Caterpillar (*Malacosoma pluvialis* Dyar)—There has been a marked increase of this caterpillar on hosts of the rose family on South Vancouver Island.

Forest Tent Caterpillar (*Malacosoma disstria erosa* Stretch)—This species has not been troublesome on the Lower Mainland.

Western Hemlock Looper (*Ellopia somniaria* Hulst)—An outbreak of this defoliator occurred over an area ten miles long near Burrard Inlet. Western hemlock was mainly attacked and complete defoliation occurred. Balsam, Douglas Fir, Spruce, White Pine, Maple and Alder were also affected to a lesser extent. Another outbreak has been reported from the vicinity of Alouette Lake. The last outbreak of this insect in British Columbia occurred in 1916.

Spruce Budworm (*Cacoecia fumiferana* Clem.)—Douglas Fir was heavily infested with larvae near Victoria, but three other outbreaks that occurred on Vancouver Island last year have subsided.

Fir Tussock Moth (*Hemerocampa pseudotsugata* McD.)—Two small localized outbreaks of this defoliator occurred on Douglas Fir in the Kamloops district. The last outbreak occurred in 1923 when this species was in epidemic form over a wide area from Kamloops to Kelowna.

Tortricid Moth (*Batodes angustiorana* Haworth)—Mr. W. Downes has reported the occurrence of this moth in Victoria where it has caused considerable damage to Yew trees. He states that it is of European origin and has not previously been recorded from North America.

Black Hooded Tip Moth (*Peronea variana* Fernald)—An outbreak of this insect occurred last year in Hemlock at Brittania, Howe Sound. This has very greatly decreased during the present season and no further epidemic outbreaks have been reported.

Willow Leaf Beetle (*Galerucella carbo* Lec.)—This insect was unusually abundant in the interior of the province and caused considerable defoliation of willows and poplars.

Alder Flea Beetle (*Haltica bimarginata* Say.)—This beetle has been abundant in many parts of the province, and caused complete defoliation of willows in some sections of Vancouver Island.

Bark Beetles.—Fortunately no epidemic infestations of bark beetles in Yellow Pine occur in the province at the present time. The greatest losses to the lumber industry in British Columbia are occasioned by outbreaks of the Mountain Pine Beetle (*Dendroctonus monticolae* Hopk.), and the Western Pine Beetle (*Dendroctonus brevicomis* Lec.), in Yellow Pine. During the epidemic infestations of the past twelve years, it is estimated that 250 million board feet were killed by these outbreaks.

Mountain Pine Beetle (*Dendroctonus monticolae* Hopk.)—Heavy infestations of this beetle occurred in Lodgepole Pine in the Kamloops district, North Thompson Valley, South Okanagan and West Fork of the Kettle Valley. These outbreaks have been active for several years. An outbreak is also reported in White Pine in the Glacier National Park.

Douglas Fir Beetle (*Dendroctonus pseudotsugae* Hopk.)—There have been a number of small outbreaks of this beetle in Douglas Fir stands in the Central and Southern sections of the Interior.

Western Cedar Borer (*Trachykele blondeli* Mans.)—Extensive infestations of Cedar by this borer occur in the Coastal sections. A detailed investigation of this insect has recently been completed by Mr. George Hopping.

Soft Scale (*Lecanium caprae* L.)—Outbreaks of this scale have been very troublesome in past years on boulevard trees and parks in Vancouver. It was considerably less numerous during the present year.

UNIDENTIFIED SAWFLY.—Large numbers of sawfly larvae were found to infest Jack Pine in the Shuswap Lake district.

INSECTS AFFECTING LIVE STOCK AND MAN

BITING FLIES.—One of the outstanding features of the season has been the great abundance of various kinds of biting flies. Mosquitoes have been far more troublesome than has been the case for many years; and in some sections, outbreaks have been more severe than can be previously remembered. The high water level from the previous wet seasons, the abnormally heavy snowfall, and the extremely high floods have been responsible for much of these conditions.

MOSQUITOES.—In the early spring months the species *Aedes campestris* Dyar & Knab, and *Aedes cataphylla* Dyar, were extremely numerous throughout the Chilcotin and Nicola range lands and caused a great deal of trouble to live stock owners. *Aedes vexans* Meigen, *Aedes aldrichi* Dyar and Knab, *Aedes hirsuteron* Theobald, and other flood water species later occurred in very severe outbreaks in river valleys and lake areas flooded by the abnormally high spring freshets.

BLACK FLIES.—Small streams were filled for a longer period than usual and Black Flies were very troublesome, especially at high elevations and in the rangelands of Central British Columbia. In the Chilcotin district *Simulium venustum* Say, was abundant. *Prosimulium fulvum* Coquillett and *Prosimulium novum* Dyar and Shannon, were noted to be numerous and troublesome on high mountain sheep ranges in the North Thompson district. *Simulium virgatum* Coquillett, *Simulium vittatum* Zett, *Prosimulium hirtipes* Freis and *Prosimulium pleurale* Malloch, were other species noted to be common in the dry belt.

TABANIDAE.—These flies were unusually abundant and troublesome on cattle and sheep ranges especially at fairly high elevations. On high ranges in the North Thompson Valley *Tabanus osburni* Hine, was the main troublesome species in July. *Tabanus sequax* Will., was abundant at high elevations in the Lower Mainland; and *Tabanus punctifer* O.S., was locally troublesome in the dry belt.

BITING LEPTIDS (*Symphoromyia atripes* Bigot)—These flies were so unusually numerous and troublesome that horses were almost unmanageable in some places and stockmen enquired if a new pest had been introduced. While particularly abundant in mountain areas this pest was troublesome on the ranges in the Chilcotin and Nicola districts. Another species *Symphoromyia plangans* Will., was observed in some numbers in mountain sections in the Lower Fraser Valley.

HORN FLY (*Lyperosia irritans* L.)—This fly occurred in much more than normal numbers and was extremely troublesome to cattle throughout the province.

TICKS, WOOD TICK (*Dermacentor venustus* Banks.) and MOOSE TICK (*Dermacentor albipictus* Pack.)—The last few wet seasons have evidently affected ticks adversely, for they were found to be abnormally scarce this year.

WARBLE FLIES (*Hypoderma lineata* De Villiers) and (*Hypoderma bovis* De Geer)—Warble flies are extremely troublesome in the interior range lands and the dairy sections of the Lower Fraser Valley and constitute a most important pest of cattle in British Columbia. During the worst months in the early spring it is estimated that about 75% of the hides received at the tanneries are grubby. It is probable that the infestation in the coming spring will be less than normal on account of the wet spring of the present year.

HORSE BOT FLIES (*Gastrophilus haemorrhoidalis* L.)—(*G. nasalis* L.) and (*G. intestinalis* De Geer)—These flies have been somewhat less troublesome than usual. They are more noticeable in the Interior range lands than elsewhere.

SHEEP NOSE MAGGOT (*Oestrus ovis* L.)—Very little trouble was reported from this fly. Slight infestation occurred in small farm flocks in the Kelowna district.

HOUSE FLIES (*Musca domestica* L. etc.)—In general domestic flies were less numerous than usual. They were very troublesome, however, in the Lower Fraser Valley.

MISCELLANEOUS INSECTS

EUROPEAN EARWIG (*Forficula auricularia* L.)—Earwigs are reported as steadily spreading in the coastal districts. They caused severe damage in on section by feeding on the silk cobs of standing corn.

BEDSTRAW HAWK MOTH (*Celerio gallii intermedia* Kirby)—The larvae of this moth occurred in enormous numbers of Fireweed on parts of Vancouver Island and the Lower Mainland. When this food supply was exhausted willows were attacked.

WOOLLY BEAR CATERPILLARS (*Diacrisia virginica* Fabr.) and (*Isia isabella* A. and S.)—These caterpillars were unusually abundant this year. The former has never before been observed to be sufficiently numerous to cause any damage in the Lower Fraser Valley; but this year it caused considerable injury to Geranium, Gladiolus, etc. The latter was very abundant in the interior districts.

ROSE SAWFLY (*Cladius pectinicornis* Four.)—This insect was very abundant and caused injury to roses in the Lower Fraser Valley.

CHRYSOMELID BEETLE (*Calligrapha californica* Linell)—This beetle seriously affected plants of the tickseed or *Coriopsis* in the Abbotsford district.

TARNISHED PLANT BUG (*Lygus pratensis* L.)—These bugs caused damage to commercially grown chrysanthemums at Robson.

DRUG STORE BEETLE (*Sitodrepa panicea* L.)—This beetle was noted infesting red pepper, curry powder and other similar products in Vancouver.

INSECTS OF THE SEASON 1928 AROUND VANCOUVER, ESPECIALLY POINT GREY

G. J. SPENCER, UNIVERSITY OF BRITISH COLUMBIA

Owing to my absence from the Province until the first week in September, I can record only a few insects for this season and of these, most are limited to the western part of the city of Vancouver.

Painfully noticeable this year was the house fly *Musca domestica* Linn., found breeding in immense numbers in the extensive manure piles of the University farm some 600 yards from the main buildings. The flies spread (especially from this source) all over the peninsula of Point Grey until they reached the proportions of a plague. The University authorities were urged to make use of the Twinn-Herman fly spray formula (Scientific Agriculture, Vol. VIII No. 7, March, 1928) which I had forwarded the Bursar last spring in the event of just such an outbreak of flies. Sixteen gallons of spray were made on the premises at a cost of $15.76 and the poison was supplied to all janitors in all buildings. The spray was found

very effective and was used freely. Splendid killing was obtained and no staining of walls or furniture was reported in any of the reading or rest rooms. Moreover, Minnesota fly traps (Washburn) were tried out near the barns and it was found that a trap would catch 10,000 flies in twenty-four hours with a bread and milk bait.

This fall the dense second-growth of alders for two miles along the road on the University Endowment lands and all over the forest plots was heavily infested by aphids which I take to be *Myzocallis alnifoliae* (Fitch) (Glendenning R. Proc. Ent. Soc. of B.C. No. 22, 1925).

Every alder was infested and so heavy was the fall of honey dew that not only the alders but all trees growing under them were blackened by the fungus *Cladosporium* sp. I have not seen this effect since coming here in 1924.

Another aphis, a red species, occurred in quantity on the leaves of water lilies on the University ponds, and in Stanley Park the thousands of water lily leaves in Beaver Lake were absolutely plastered with them. The infestation lasted until the middle of October. I collected these insects for the first time in 1925 near Victoria and Auden made the first collection taken in the Province, somewhere in the interior, in 1923, so their spread has been very rapid. They infest all parts of the lily plants that extend above water.

This year for the first time at the University a large collection was made of the curious apneustic, transparent larvae of genus *Chaoborus* of mosquitoes which occurred in a rain pool on the campus. The pool was dry the first week in October and the larvae were found the first week in November. Hearle records several species in B. C. The season has been very dry this year. For practically three months this summer, no rain fell and this condition may possibly account for the following items:—
Ground beetles, of several small species are present in pasture fields under sod and on the edges of the woods, in unusually large numbers. The European beetle *Carabus nemoralis* which Auden took first in 1923 and I took in quantity in 1924 and succeeding years, may be found at this time (Nov. 8th.) very commonly hibernating in rubbish in matted sod and in tufts of grass along the edge of woods. The females are heavily grained. Click beetles, principally small species, are also very common. Some are attracted to lights in houses. In contrast, the Strawberry Root weevil *Brachyrhinus ovatus* (Linn.) ubiquitous and normally abundant under rubbish at this time of the year, is scarce this fall. Likewise Crane flies and Caddice flies and the large lacewing *Polystoechotes punctatus* (Fabr.) which are usually abundant every autumn, are scarce, especially the lacewing.

There have been no complaints and enquiries about the Malodorous Carabid *Nomius pygmaeus* (Dej.) sent into the University this year. For three seasons past the insect seemed to be on the increase, and, contrary to usual opinions, to be entering houses freely where its ejection or slaughter rendered the room uninhabitable unless fumigated. Summer before last one of the leading hotels in town was greatly disturbed over this insect which was entering rooms in upper floors (Sixth floor and upwards).

There have been noticeably fewer clothes moths this season. While both species occur here, *Tineola biselliella* Hummel is the commonest and does much damage.

The effects of the satin moth *Stilpnotia salicis* (Linn.) on two avenues of Lombardy poplar and on one giant cottonwood in the vicinity have been observed for three summers past. This fall, the trees in question showed less recovery, i.e., fewer second growth leaves, than usual. I think it is

more the lack of moisture during the season than that the resistance of the trees has been diminished.

The fall flight of Termites *Termopsis angusticollis* Hagen occurred this year on September 23-25 in this vicinity.

Spiders of many species have been exceedingly plentiful. More than usual are invading houses and many have been sent or brought to the Department of Zoology.

The White Marked Spider beetle *Ptinus fur* (Linn.) though usually quite easy to keep out, has levied a heavy toll on collections presented to the University during the year past. The collections were not well sealed.

The mediterranean flour moth *Ephestia kuhniella* (Zeller) is abundant as usual though *Plodia interpunctella* (Hbn.) is the only cereal pest working in the grain and chop bins at the University farm barns. I have received one complaint so far of the meal worm *Tenebrio molitor* (Linn.); it was recorded from Salmon Arm in the Interior and is the first infestation that has been reported to me in four years though I have taken the insect in very small numbers, in local grain and feed mills.

A small undetermined Ichneumon was very abundant the last week in September, in pasture fields along the edge of woods. I could not determine its host.

One enquiry was sent in from a house over-run with camel crickets and one from Victoria concerning the psocid *Troctes divinatorius* (Miller) which was issuing in hordes from a set of over-stuffed furniture. The psocids were reported to be causing the velour to come out "in handfuls" so the set, which had been nine months in the house before any insects came out of it, was returned to the dealer. Psocids are always plentiful around the laboratory in any culture containing cereals.

From a fox farm at Mission, a great supply of fleas and flea larvae was sent in to the Department. I obtained a further supply of larvae rubbish from the pens and incubating them at 37° C. with moisture at about 80° procured an abundant emergence of adults. Specimens were sent in, of the hen louse *Lipeurus caponis* (Linn.) (*L. variabilis* Nitzsch). This is the first infestation of this louse that I have had so far.

The European Earwig *Forficula auricularia* (Linn.) has, according to my enquiries, been very materially reduced in the West End of Vancouver where it has hitherto been very abundant. This reduction is attributed to the poison campaign, instituted by Mr. Glendenning of the Dominion Entomological Branch and carried out by the city. But in Point Grey municipality which has been free of these pests so far, it has this year appeared in numbers.

THE PRESENT STATUS OF CORN BORER PARASITES IN CANADA

A. B. Baird, Entomological Laboratory, Chatham, Ontario

Preliminary studies made by Crawford and Spencer at Port Stanley, Ontario, in 1921 and 1922, indicated that parasites were not attacking the corn borer to any appreciable extent. A common native Tachinid, *Zenillia caesar* was the only species found and this in relatively unimportant numbers. More extensive studies made since that time throughout south-western Ontario have revealed the fact that native parasites are not attacking this pest effectively and are still a negligible factor in control. The following species have been reared from various stages of the borer: *Trichogramma minutum* Riley, attacking the eggs deposited late in the summer; *Habrobracon tetralophae* Vier; *Habrobracon* sp., and *Micro-*

bracon mellitor Say, attacking the small larvae; *Zenillia caesar* Ald., *Phorocera erecta* Coq., and *Erycia myoidaea* Desv. attacking the larger larvae; and *Labrorychus prismaticus* Nort. attacking the pupae.

With the exception of *Trichogramma* and *Zenillia* only an occasional specimen has been found. *Trichogramma* was quite abundant in 1924 and 1925 but appeared late in the season when a large percentage of the corn borer eggs had hatched. A few specimens of *Zenillia* have been reared each season particularly from larvae collected during late autumn and early spring. In no case, however, has the parasitism reached one per cent. No information has been secured regarding parasitism in the more recently infested territory in Ontario, Quebec and New Brunswick, and a study of these districts is planned for the coming year.

Investigations on the corn borer made in Europe by the U. S. Bureau of Entomology revealed the presence of several species of parasites that were helping to reduce its numbers, and through the courtesy of officers of the Bureau in supplying breeding stock of *Microbracon brevicornis*, the introduction of parasites into Canada was begun in 1923, headquarters being established at St. Thomas, Ontario. Papers published in the annual reports of this society for 1924 and 1925 record the progress of the work up until that time and during the latter year the laboratory was removed from St. Thomas to Chatham.

In 1926, two additional species, *Microgaster tibialis* Nees. and *Apanteles thompsoni* Lyle, were introduced, a small liberation of each species being made at Chatham. These species were augmented by further introductions in 1927 and 1928 and two new species have been added, viz., *Eulimneria crassifemur* Thom. and *Macrocentrus gifuensis* Ashm. Six European parasites of the corn borer have thus been introduced into Canada in the six-year period and a total of more than three and one-half million adult parasites have been liberated at strategic points in the areas most heavily infested by the pest. Table 1 gives a summary of the liberations of each species showing the localities in which they have been colonized.

TOTAL NUMBERS OF IMPORTED SPECIES OF CORN BORER PARASITES

LIBERATED IN CANADA TO OCTORER 31, 1928

	ONTARIO				QUEBEC		
	Elgin	Kent	Essex	Prince Edward	Welland	St. Martins	TOTAL
Microbracon brevicornis	1,081,500	1,541,000	319,000	89,000	149,000	95,000	*3,274,500
Exeristes roborator	17,100	126,850	22,350	9,005	7,545	2,200	* 185,050
Microgaster tibialis		25,799	13,519	10,445	4,745	4,050	† 58,558
Apanteles thompsoni		1,953	364	100			2,417
Eulimneria crassifemur		4,457	3,190	2,540			10,187
Macrocentrus gifuensis		10,482	3,730	1,463	1,921	1,242	19,138
					GRAND TOTAL		3,549,850

* From laboratory bred material.
† 1,937 flies from laboratory bred material.

It will be noted that liberations of the first two species have been much more extensive than the remaining four. This is accounted for by the fact that their maggots feed externally upon the mature borers and thus lend themselves more readily to laboratory production than the other species the maggots of which develop internally in the small growing stages of their host.

The fact that a parasite can be bred in large numbers readily in the laboratory does not necessarily mean that it will increase rapidly under all conditions in the field. It has been found in Europe that certain species are more effective in some regions than in others and this condition will doubtless be duplicated in America.

It has not been possible as yet to determine whether all species are becoming established at the several liberation points. Our recovery work has been confined almost entirely to Kent county where numerous field observations and cage experiments have been conducted. These have resulted in the recovery of several spcimens of *Microbracon, Exeristes, Microgaster* and *Macrocentrus*.

In order to facilitate the obtaining of information regarding the parasites, a large cage (75 feet by 21 feet) covered with 20-mesh wire screen was erected at Chatham in the spring of 1928. The stalks from a four-acre corn field near our liberation site were placed in this cage after having been wintered under natural conditions in the field and from this material we recovered 33 adults of *Microgaster*, 72 *Exeristes and* 149 *Macrocentrus*. This is sufficient to indicate that these three species at least can attack the corn borer successfully and withstand overwintering conditions in this section.

Supplementing the introduction of foreign parasites an attempt is being made to utilize the native egg parasite *Trichogramma minutum* in the biological control of the borer. Several experiments were conducted this past season and some 46,000 adults were liberated but the work has not progressed sufficiently for us to form any conclusions as to its possibilities.

The whole project is being conducted in close co-operation with the United States Bureau of Entomology whose assistance and courtesy we gratefully acknowledge.

NOTES ON THE LIFE-HISTORY OF THE EUROPEAN CORN BORER IN ONTARIO

Geo. M. Stirrett, Entomological Laboratory, Chatham, Ont.

No detailed records of the life-history of the European corn borer, *Pyrausta nubilalis* Hubn., have been published in Canada since 1922. It is for this reason that it is deemed advisable to record at this time the following notes on its life-history, as it occurred in the field at Chatham, Ontario, during the years 1927 and 1928. Because of the more or less inactivity of the larvae during the winter months little need be said of this period except to point out that the winter mortality of larvae in corn stalks and stubble above ground for the two years under discussion was about average, i.e., about 6.5 per cent.

The Seasonal History In 1927

Pupation.—The first pupa was found in periodic sample counts on June 3. This date was one day earlier than in 1926, when the first pupa was found on June 4. Pupal development was rather slow in progress until June 15 as by this date only 24 per cent. of the larvae had pupated. During the next 14 days the rate was more rapid, reaching 94 per cent. by June 29. Pupation was completed by July 13 as further counts after that date showed all larvae had pupated. Pupal development did not proceed at the same rate even within a limited area, thus on the shore of Lake

Erie, 12 miles south of Chatham, pupation began about June 15 as on this date only four per cent. of the larvae had pupated at this point whereas at Chatham on the same date pupation was 24 per cent. completed. The rate of pupation was faster in the lake-shore stubble field as it was completed on July 11, while at Chatham it was not completed until July 13. The fields in which the counts were made were similar in all respects except location.

EMERGENCE.—The first adult emerged in the field about June 24, when a count showed that two per cent. of the pupae present in the field had emerged. This was three days earlier than in 1926, when the emergence count showed that one per cent. had emerged by June 27. Emergence proceeded gradually and by July 16 all the pupae present in the field under observation had emerged. On the lake-shore only four per cent. of the moths had issued by July 8 and emergence at this point did not become completed until July 27, 11 days after its completion at Chatham.

FLIGHT OF MOTHS.—A quantitative study of the flight of moths throughout the flight season was made, but only the general progress of the flight will be outlined in this paper. Although counts showed that emergence began at Chatham on June 24 it was not until July 1 that moths could be found in the field and only on July 8 that they became frequent. On this night we secured 13 moths in the plot. The number of moths secured gradually increased until July 13, when the maximum flight for any single night of the season took place. On this night 116 moths were captured in the plot. The moth flight gradually decreased until it ended on August 7. Observations were continued until August 11, but no moths were secured after the former date. In all, from July 8 to August 7, a total of 894 moths were secured in the plot.

During the period of flight, moths were absent from the field on seven nights. On each of these nights the mean temperature during the early evening dropped below 58 degrees F. It is, therefore, safe to conclude that moths do not frequent fields, if the temperature drops below 58 degrees F. even in the height of the flight season.

In the nightly cycle of flight it was found that the moths commenced to come into the field about 8.20 p.m. as only occasionally were moths seen earlier than this time. The largest number of moths were found between 9.00 p.m. and 9.15 p.m. After this time the moths gradually became fewer, until between 12.00 p.m. and 1.00 a.m. hardly any remained. It was only very occasionally that moths could be seen at 1.00 a.m.

OVIPOSITION.—The first egg mass was found on July 2 in the field, eight days after emergence had started and when it was about 12 per cent. complete. Regular oviposition counts were started on this date in the large corn field and the eggs deposited on 50 plants were recorded throughout the season. Egg laying commenced in this field on July 9 when four masses were found. The largest number of masses for any one day were secured on July 18, when 87 masses were obtained. Egg laying stopped on the night of August 10, as no eggs were found after this date. The total number of egg masses laid on the 50 plants was 336, or 6.72 masses per plant, for the season. The average number of eggs per mass was 17.

INCUBATION PERIOD.—No regular observations were made to secure the date of the first hatching, but allowing from five to seven days as the incubation period the first larvae must have hatched during the period July 7 to 9.

LARVAL DEVELOPMENT.—By July 25 early feeding scars of the young larvae were conspicuous on the corn leaves, indicating that first and second instar larvae were present in numbers in the field. Fourth instar larvae were found in Essex county on or about July 30-31.

The Seasonal History in 1928

Pupation.—Owing to the success and thoroughness of the clean-up it was difficult to find a field in which to secure pupation and emergence counts. A field was finally found near Chatham and the first count taken on June 14. At this date 3.92 per cent. of the larvae had pupated. Pupation was somewhat later than in 1927 because on June 13, 1928, 5.9 per cent. had pupated while on June 15, 1927, 24.0 per cent. had pupated. Pupation was complete on July 18. This date is five days later than in 1927.

Emergence.—Emergence began about June 28 as on this date 3.12 per cent. of the pupae had emerged. It continued somewhat later than July 18 because on this date, the last count taken, only 94 per cent. of the pupae had emerged. The dates for emergence are only a few days behind those of last year.

Flight of Moths.—Although emergence began a short while before June 28 it was not until July 7 that moths could be found in the fields at night. On July 7 emergence was about 13 per cent. complete. The appearance of the moths in the field was six days later than last year.

The study of the flight of moths begun last year was continued during the present season along the same general lines. The plot under observation, however, was just one-half of the area used last year and to make our figures comparable the actual figures obtained in the field during the present season have been doubled. The corrected figures are used in this paper.

Moths were found in the field from July 7 to August 9, after which date no moths were seen in the plot. The flight period, in relation to dates, with the exception of the earlier appearance of a very few moths in 1927 as indicated above, and the length of duration was almost identical with the flight of the previous year. The maximum flight took place between July 14 and 24. The largest flight for any single night occurred on July 16 when 62 moths were observed in our plot. During the entire flight period 400 moths were observed. This is a marked reduction from the year previous, when 894 moths were secured.

During the flight period moths were absent from the field on nine nights. Their absence on two of these nights is explained by low temperature and heavy rain explains their absence on a third night. The reason for their absence on the other nights is not yet clear. As determined last year the moths do not fly when the temperature becomes as low as 58 degrees F. in the early part of the night. This is well illustrated on the night of July 13 when at 7.45 p.m. the temperature was 58 degrees F. No moths flew on this night. The evening before nine moths had been secured, the temperature being 65 degrees F. at 8.00 p.m. The following night eight moths were secured, the temperature being 64 degrees F. at 8.00 p.m. The other meteorological conditions for the three nights were practically the same.

The nightly cycle of flight was found to be the same as in 1927. A small secondary flight, taking place between 2.15 a.m. and 4.10 a.m., was noted on July 17. This was the only night the observation was made, but it is very likely this small flight takes places each favorable morning.

Oviposition.—The first egg mass was found in the field on July 4, but this was exceptional because egg-laying proper did not begin until July 8. This date was eight days after emergence was begun and when it was about 15 per cent. completed. Regular daily oviposition counts were made on 50 plants in our corn field throughout the season and the following data were secured. The egg laying period extended from July 8 to August 8 inclusive. Towards the end of the period no eggs were laid on the plants from July 29 to August 8, on which date one egg mass was

found. The dates of the egg-laying period coincide with those of last year. The maximum egg deposition occurred between July 11 and July 21. The largest number of egg masses for any single night were laid on July 21. The total number of egg masses laid on the 50 plants during the season was 55, or an average of 1.1 egg masses per plant. This is a marked reduction from 1927, when 6.72 masses were laid per plant for the season. The average number of eggs per mass for the season was 15.54.

It is to be noted that in our plots we observed 2,235 times as many moths in 1927 as in 1928. Our egg counts indicate that 6.1 times as many egg masses were laid in 1927 as in 1928. The egg counts were not taken in the same fields as the moth counts, but the results probably indicate what was happening in the general field. The number of eggs per mass was also larger in 1927. The average for the season was 17 eggs per mass in 1927 and only 15.54 per mass in 1928.

INCUBATION PERIOD.—The average duration of the egg stage for the season based on 71 masses was 6.09 days. The shortest length of time was three days and the longest length of time was nine days. It was found that 97.13 per cent. of the eggs observed in the field hatched. The eggs began to hatch on July 14 and continued to hatch until August 11.

LARVAL ESTABLISHMENT.—A plot of 70 plants, surrounded by 106 plants which were kept free of eggs during the season, was used to determine the number of larvae establishing themselves in the corn plant and maturing to third or fourth instar larvae. The eggs recorded and observed on the 70 plants were deposited through natural infestation, upon a Dent variety, Wisconsin number seven, planted on June 5. The stalks were cut up and the borers counted on August 20 to 22. A total of 1,082 eggs were laid on the plot of 70 plants throughout the season. 97.13 per cent. of the eggs hatched (1,051 eggs) and yielded, on August 20-22, 381 live larvae and six dead larvae. In the two rows immediately surrounding the plot 57 larvae were secured. Therefore, 444 larvae established themselves from 1,051 eggs. The mortality in the early instars of the larvae was 57.76 per cent., or a survival of 42.24 per cent. This is a very low mortality when compared to the average mortalities for the years 1924, 1925 and 1926, as given by Marshall (1) THE LARVAL MORTALITY OF THE EUROPEAN CORN BORER IN 1926, 57 *Annual Report Ent. Soc. Ontario,* 1926 which are as follows: 1924—77.73 per cent.; 1925—93.58 per cent. and 1926—86.8 per cent.

CORN INVESTIGATIONS IN RELATION TO THE EUROPEAN CORN BORER

AT MICHIGAN STATE COLLEGE

A. R. MARSTON, MONROE, MICHIGAN

Members of the Ontario Entomological Society, it gives me extreme pleasure to be present with you at this time and to be able to tell you of some of the investigations we are carrying on in Michigan in relation to the European Corn Borer.

We feel sure that it will not be any single practice that will control the European Corn Borer, but that it will be a combination of Mechanical methods, General crop practices, Parasites, the possible growing of corn that may be more or less resistant or distasteful to the borer, and other measures which will enable the corn industry to continue profitable development despite the corn borer.

Our work at Monroe has been carried on co-operatively by the Farm Crops Department and Entomology Department of the Michigan State College. The Michigan State College three years ago, leased the present site at Monroe to carry on their investigations, because at that time there were no corn borers at the College, and it was desirable to carry on investigations under corn borer conditions. You can well understand it is necessary to carry on Agronomy investigations over a period of years in order to get average results that would cover seasonal variations. Some of the investigations which we have been carrying on are as follows: Date of Planting, Stage of Growth Relative to Corn Borer Moth Oviposition, Rate and Spacing, Fertilizer treatments, Plant Breeding, Topping, Date of Harvest, Moth Emergence from Screen Cribs, Plowing, Trap Crops, Miscellaneous Crops, Cultural Practices, Life History, Mugwort versus Corn, Survival and Migration of Larvae, and Migration of Borers and Moth Emergence from Shocked Corn. Many of these investigations have been carried on for three (3) years.

Most of the projects which I have mentioned are projects which have been carried on by other Corn Borer Experiment Stations. However, the breeding work which we are carrying on as our major Agronomy project, is of special interest and seems to promise unusual results. This consists of an attempt to breed a variety of corn which will be resistant, or partially resistant, to the attack of the European Corn Borer, and at the same time to obtain a variety which will be high in yield, early in maturity, and carry as many as possible of the best characteristics of our standard Michigan varieties.

The program which we are following comes under two divisions.

1. Selection From a Large Number of Selfs and Crosses of Our Common Corn Varieties of Michigan, Ohio, Wisconsin, Minnesota, and Illinois for Resistance to the Corn Borer.

2. Breeding for Resistance by Crossing a Known Resistant Variety With Our Common Michigan Varieties.

The work in the first division consists of studies of the physiological and chemical characters of these different strains in order to study the reasons for any preference the borer may have for these strains. With this knowledge we hope to breed varieties that will not possess those characteristics that the borer likes best. In doing this it has been necessary for us to make Fibro Vascular Bundle Counts of the stalk, epidermal hardness and thickness, and size of the stalk in relation to height, width of leaves, number of leaves, and chemical determinations in the studies of sugar and acid contents of these different strains. Under this division of our breeding program we are in our second or F-2 generation, and although we do find a significant difference between strains, as far as infestation goes, we do not get a decrease in infestation that would justify us in believing that we had any strains that were immune to the corn borer, in the 2,500 strains studied this year for borer resistance. These strains were from selfs and crosses made in 1926 on common varieties of Ohio, Wisconsin, Minnesota, and Michigan corn.

The work in the second division consists of the crossing of the Maize Amargo variety of corn, which appears to have borer resistant characteristics, with our Michigan varieties, in order to bring out a new variety which would have this character of borer resistance and also give a high yield and safe maturity. The Maize Amargo is a variety of corn which takes some 200 days to mature and thereore cannot be grown profitably in Michigan.

At present we are in the 2nd or F-2 generation of these crosses, and although we are merely in the experimental stage and have no definite facts to give on the project, the situation looks very encouraging.

In 1926 we were able to cross Maize Amargo, which shows resistance to the European Corn Borer, with three (3) of our Michigan varieties of corn: Duncan, Golden Glow, and Red Cob Ensilage. We only had 6 kernels of the Duncan cross, and of the Golden Glow and Red Cob Ensilage we had a few dozen kernels each. Of this stock we furnished Dr. F. D. Richey, of Washington, a few kernels of each, as he had been unsuccessful in getting any of his crosses to grow up to that time.

In 1927 we planted this seed, and only 2 plants of Duncan, about 4 plants of Golden Glow, and about 9 plants of Red Cob Ensilage grew. This was our F-1 or first generation, and we covered most of these plants with screened cages in order to protect them from corn borer attack, until we could get them into the F-2 or second generation. The plants which were not protected suffered considerable corn borer injury. This gave us some concern as to the outcome of the cross.

In 1928, this past season, we planted all of the seed harvested from the plants in 1927. It germinated well and gave us a large number of plants with which to work. In planting these crosses we also planted along with them a few rows of the parent plants. This generation began to show results which were more encouraging than those of the year before. Mr. C. B. Dibble of the Entomology Section of our Station found a heavy infestation on the Michigan parent, but on the progenies of the crosses with Maize Amargo he found a rather light infestation. By infestation, is meant preliminary counts made by Mr. Dibble and his assistants on the number of plants infested, and the number not infested in the plot. For example, pure Duncan corn gave us an infestation of 68%; pure Maize Amargo, right beside it, gave us an infestation of 5%; and the 2 progenies of the Duncan Maize Amargo Cross, grown adjacent to these plants, 18% and 8% respectively. All of these were planted at the same time and all grew normally for height. This gives us some promise that we may be able to get something that will be partially or even totally resistant to the corn borer. Of course we must understand that this year we have a segregation of factors as we are working in our F-2 generation. If it is a simple Mendelian segregation we should have a breaking up according to a 3-1 ratio of susceptible and immune plants. We had a heavy infestation in our F-1 generation both in 1927, and this year, in F-1 crosses of Maize Amargo and Michigan varieties. This leads us to believe that possibly susceptibility is a dominant factor, and if such is the case immunity must be a recessive. We have hand pollinated all the plants we could in these plots, and will study them as individual plant rows next year: Should there be immune plants among these according to a Mendelian segregation, we should have whole rows next year that are immune. We are not wholly convinced that it is a simple Mendelian factor, and are not taking any chances by studying a small number but will study some three or four thousand individual plant rows next year.

It may take several years to develop a new corn that will be a profitable variety to grow in the state of Michigan, even though it does carry resistance to the borer, for it must give a high yield, and mature at normal date in addition to any other desirable characteristics it may have. Nevertheless, such an achievement, even though it takes several years, will be well worth while.

THE PERCENTAGE AND NUMBER OF EUROPEAN CORN BORERS WINTERING IN THE PARTS OF CORN STALKS BELOW THE SURFACE OF THE GROUND

R. W. Thompson, Ontario Agricultural College, Guelph

The cultural methods in Kent and Essex counties are such that, if possible, some method of clean-up other than by ploughing is desirable. Hence, at the request of the Essex County Council, Clause 5 of the regulations under the Corn Borer Act which made ploughing compulsory, has been changed to read as follows: "Corn shall be cut level with the ground and all remnants gathered and burned, or if cut higher, the stubble shall be ploughed under completely and if any of it is dragged up later when cultivating it shall be gathered and burned within ten days." This amendment is in force as an experiment for one year only and may be struck out or changed at the end of the year, if it is found necessary to go back to ploughing. Whether it will be safe to dispense with ploughing under the above conditions can in part be judged from data obtained by the writer in examinations of fields in Kent and Essex counties and also by Mr. D. J. Caffrey, who is in charge of the United States Corn Borer Control Staff.

The fields examined by the writer will be dealt with individually and later compared with the data obtained by Mr. Caffrey.

1. Field of W. C. Abraham, Near Chatham.

During the latter part of October, 1928, examinations of one thousand stubble were made in this field which was a light clay loam, planted to Dent corn, on June 6th. The plants were fairly well developed though the number of cobs were somewhat small. Quite a number of the stalks were still quite succulent although the tips were badly frozen. Because the field was long and narrow an average row of stalks lengthwise through the centre of it was taken for examination. First, two hundred stalks complete with their roots were dissected throughout to ascertain the number of worms therein and thereby calculate the total borer population per acre. At the same time record was kept of the numbers of borers found at points corresponding to the heights listed below. The remaining eight hundred stalks were then cut with a hoe at a measured height of four inches above the ground. These stubble were then dissected to the end of the root and record taken of the number of borers occurring (1) below the ground surface; (2) in stubble one inch above the ground; (3) two inches high; (4) in stubble four inches high.

Since the corn was drilled it was necessary to measure the number of feet of corn rows occupied by the examined stalks, in order that the number of plants per acre could be estimated. This number was found to be 16,416 which with a borer population of 4.1 borers per stalk, would give a total borer population per acre, of 67,360 borers. Of this total, 2.34% were found to occur below the surface of the ground and hence 1,574 represents the number of borers found below the soil surface.

A tabulation of the number of borers found in the stubble at the various heights, with the corresponding percentage in each case of the total original borer population per acre reveals the following points:

Table Showing Results Obtained in Field No. 1*

Height of stubble.	No. living borers in 1,000 stubble.	Estimated No. borers per acre.	Estimated No. borers per acre. in stalks.	Per cent of total borer population.
0″	99	1,574	66,360	2.34
1″	148	3,944	67,360	3.51
2″	243	7,768	67,360	5.80
4″	414	14,449	67,360	9.80

*Based on 16,416 plants per acre.

Of particular importance is the percentage of borers remaining below the surface of the soil. In this series of examinations it is seen that 2.34 per cent. of the total borer population are found below the soil surface. One inch of stubble with roots included, contained 3.51 per cent. of the total borer population. This gives an acre count of 1,574 borers and 3,944 borers respectively for ground-level stubble and one inch stubble.

2. Field of T. Dawson, Maidstone.

This field was, in the opinion of the head corn borer inspector for the county of Essex, the most heavily infested field of standing corn procurable during the early part of December, 1928. The corn was Dent, planted in hills early in June and was well developed, though the number of cobs was not large.

One thousand plants were examined but owing to frost it was only possible to cut the stubble level with the ground, as the stalks were exceedingly brittle and broke at the ground level when struck with the hoe. In every case the stubble was taken from the ground, by means of a pick and dissected to the end of the root. In the 1,000 stubble thus examined, 391 borers were found. The stalk population was estimated from one hundred stalks and the average stalk infestation was found to be 7.1 borers (roots included). By calculation on the basis of 3.77 plants per hill and 4,000 hills per acre, giving a total of 15,080 plants per acre, the borer population per acre thus found was 107,068. In the corn stubble below the surface examined 391 borers were found; therefore at the rate of 15,080 plants per acre this would give 5,896 borers per acre or approximately 5.5% of the total.

Table Showing Results Obtained in Field No. 2

Height of stubble.	No. borers in 1,000 stubble.	No. borers per 1,000 stalks.	No. borers per acre.	Per cent below surface.
0″ or ground level	391	7,100	107,068	5.5+

From the above data it can be seen that there were 5,896 borers (5.5+ x 1070.68) per acre below the surface.

3. Tilbury Field.

During the second week of December, 1928, a field of black loam planted to Dent corn on June 17th., was examined. The same procedure was followed in this field as in the preceding but the corn was planted in drills instead of in hills. Two-year-old seed had been used with a resultant weak germination, hence the number of plants per acre was considerably lower than in the other fields examined.

One hundred stalks were dissected to obtain a basis for calculation of the total borer population. In addition, nine hundred stalks were cut level with the ground with a hoe and the stubble grubbed out by means of a pick and then carefully dissected.

The total borer population was estimated to be 1,820 borers per acre which made an average stalk population of .29 borers. Only one borer was found below the surface in 1,000 stubble thus giving a total of 6.5 borers below the surface of the soil in one acre. This is the equivalent of .36% or a little more than one-third of one per cent., which indicates that in this very lightly infested field a much maller percentage of the borers were beneath the surface.

Table Showing Results Obtained in Field No. 3

Height of stubble.	No. borers in 1,000 stubble.	No. borers per 1,000 stalks.	No. borers per acre.	Per cent below surface.
0″ or ground level	1	280	1,820	.76

From the above data it can be seen that 6.5 borers (1820 x .36) per acre are below the surface. This is a much smaller percentage than that which was found to occur below the surface of the soil in the heavily infested field.

4. FIELDS EAST OF TOLEDO, OHIO.

During the fall of 1928, Mr. D. J. Caffrey forwarded data resulting from the examination of four fields in the neighbourhood of Toledo, Ohio, which were cut at or close to the ground level. These fields were typical of the section and in each field a total of 50 stubble in 5 units of 100 stubble each was examined. Each stubble was examined to its base. Examinations in these fields prior to cutting supplied the data relative to borer population per acre in the standing plants.

TABLE SHOWING RESULTS OBTAINED BY MR. CAFFREY IN TOLEDO FIELDS 1928

Field No.	Estimated No. borers per ac. standing plants.	Est. No. of borers per acre left in plants cut ground level.	% total original borer popn. in plants left in stubble.
1.	12,529	223	1.78
2.	20,206	554	2.74
3.	25,080	74	.50
4.	7,087	144	2.03
Averages	13,919	222	1.59

From this data it can be seen that the averages of the four fields exmined by Mr. Caffrey show generally the results which were obtained by the writer, that is, the lighter the infestation of a field the smaller the percentage of the borer population below the surface of the ground.

TABLE SHOWING COMPARISON OF FIELDS IN 1928

Field.	Total borers per acre stalk popn.	Estimated No. borers per acre below surface	% total borer popn. found below surface.
1. Chatham	67,360	1,574	2.34
2. Maidstone	107,068	5,896	5.5
3. Tilbury	1,820	6.5	.36
4. Toledo, Ohio	(a) 12,529	223	1.78
	(b) 20,206	554	2.74
	(c) 15,080	75	.50
	(d) 7,087	144	2.03

From the above summarized results it can be seen that the heavily infested fields have a considerably larger percentage of the total borer population below the surface of the soil than have the lightly infested fields.

In Ontario we have found that most of the farmers who own these heavily infested fields are good farmers, and in nearly every case will plough their fields before putting in the next crop.

In the fall of 1927 Mr. Caffrey working in a heavily infested field near Amherstburg, Ont., found that of a total borer population per acre of 262,750 only 1,567 or six-tenths of one per cent. of this number were found below the surface of the soil. In comparison with the figures obtained in 1928, by the writer and Mr. Caffrey this is very much lower. Earlier frost and also drier weather in 1928 caused an earlier drying out of the corn stalks may be a reason for a higher percentage of the borer population occurring below the surface of the soil.

The results which have been obtained are, however, such that it appears scarcely safe to allow the amendment to continue unconditionally unless some method can be devised by which the entire corn plant stalk and root can be lifted clean of the soil. This as well as the other surface refuse must

then be gathered and burned and only by following such a plan can ploughing be dispensed with.

DISCUSSION

MR. CAFFREY.—I am surprised at the percentage of borers found by Mr. Thompson in stubble cut level with the ground. It is higher than I expected. If I remember correctly, we found last year in a badly infested field in Amherstburg, Ontario, less than 1% of the borers were below ground. I think the same would hold true in Ohio last year. The number would depend to a large extent upon whether the corn had dried out, for the borers tend to leave the upper and dry part of the stalk for the lower and more moist part as the season advances.

Mr. Thompson's figures show that we need to look more carefully into this matter, as it has an important bearing upon control measures.

MR. CRAWFORD.—I should like Mr. Thompson to tell us something about the corn at the time the counts were made. Were the stalks dried out?

MR. THOMPSON.—A fair percentage of the stalks were still succulent. Others were, however, dried out almost to the level of the ground.

THE CORN BORER SITUATION IN ONTARIO IN 1928

L. CAESAR, O.A.C. GUELPH

The European Corn Borer (*Pyrausta nubilalis* Hubn.) had already by the autumn of 1927 spread so widely through the province that it had reached every county where corn was grown to any appreciable extent. It had also spread as far west beyond the corn growing counties as to Manitoulin Island and almost to Sault Ste. Marie, and as far north into New Ontario as New Liskeard. The spread this year has been chiefly in the form of establishing new colonies in the parts of the various counties where there was only an occasional outpost last year. That this sort of spread has been quite extensive is evident from even very limited scouting, for in many places where only a rare garden plot or field was infested last year borers can easily be found this year in many a field or garden. Judging from the rate of progress in the past, I think that in about two years more the borer will be present in almost every village and town in almost every corn field in Old Ontario, and will also be widely distributed in New Ontario, wherever plots of corn are grown for table use.

AREA UNDER THE CORN BORER ACT

It has not been our policy to put the Corn Borer Act into force in every county as soon as it is known to be infested, but to wait until the infestation is near the point where appreciable losses would be likely to take place if there were no compulsory measures. In this way there is less danger of arousing the antagonism of the farmers and a better opportunity of gaining their co-operation—a thing which is of course essential for success.

The Act came into force in the fall of 1926. That fall and the next spring eight counties, namely, Essex, Kent, Lambton, Elgin, Middlesex, Oxford, Norfolk and Prince Edward were put under it. In the fall of 1927 seven more entire counties and parts of nine others were included. This fall there are twenty whole counties and half of four others under the Act. The area where clean-up measures are now compulsory includes all of Ontario west of Toronto except the counties of Bruce, Grey, Simcoe, Dufferin and the Northern half of Wellington; and east of Toronto all of Durham, Northumberland and Prince Edward, nearly all of York and Ontario and half of Hastings.

It is probable that next year several more counties will be brought under the Act, but I do not expect that it will be applied to the whole of Old Ontario for several years.

Attitude of the Farmers to the Act

When one considers the fact that the majority of farmers have had to hand-pick their corn field after ploughing and sowing them, and that this required in many cases the work of one man for from three to six days, it would not seem surprising if many of them had refused to comply with the regulations and had banded themselves together into an organized opposition. It speaks well, therefore, for their intelligence and respect for law that with very few exceptions they have readily done their share and done it well. Of the twenty-four counties in whole or in part under the Act last year, the clean-up in twenty was just about as good as any fair-minded person could ask for, and in the other four counties the failure to get so good a clean-up was not due to the opposition of the farmers but to the failure of the inspectors to do their part as well as they should. I think I am correct in stating that in three-quarters of the counties no prosecutions had to be made for failure to comply with the Act. The total number of prosecutions during the season was very small and fully half of them were not due to failure to clean-up well but to the refusal to plough the corn ground before planting the next crop.

I should like to have you remember that the co-operation of the farmers was not due merely to their high respect for law in general but to their belief from what they had seen and heard, that this particular law was necessary for the preservation of corn growing; in other words the factor of self-interest helped greatly.

Results Obtained Under the Act

In 1927, as reported at last year's meeting of this society, there was a reduction in five out of the eight counties under the Act, which was very encouraging for the first year. This year, the results in the much enlarged area have again been very encouraging: In the six most heavily infested counties of the Province in 1927—Essex, Kent, Lambton, Elgin, Middlesex and Welland—the stalk infestation has been reduced from an average of 47.4% to 27.3%, a reduction of 42.4%. This figure, however, does not allow for a considerable increase in the amount of corn grown this year in Essex and Kent and for the much larger amount of late corn in Lambton. But making allowances for all factors that should be taken into consideration, we are safe in saying that in these counties there was an average reduction of at least 33%. As the actual number of borers per stalk decreases more rapidly than the percentage of stalk infestation this would mean a decrease of considerably more than 33% in the total number of borers.

Of the remaining counties, with a few exceptions, we had not sufficient data for 1927 to determine accurately the amount of decrease or increase this year, but from personal observation, the opinion of the inspectors and of the farmers themselves, and what data were available, I know that decreases took place in Haldiman, Lincoln, Wentworth, Brant and Wellington, that there was at least no increase in Oxford, Waterloo, Halton and Peel; and that the only counties in which there were definite increases were Norfolk, Prince Edward, Durham, Northumberland and Hastings. So that on the whole the results of the clean-up under the Act this year have been decidedly encouraging. It is especially gratifying to know that, although in Essex and Kent in 1926 there were over 1,000 square miles in which all the corn was either ruined or almost ruined, this year in these two counties there were not a dozen fields ruined.

Comments on Results

Though there is good reason for feeling optimistic over the season's results as a whole, yet there are some perplexing and rather worrying aspects of them. The chief of these is the fact that in spite of a good clean-up, just as good as in any county, the borer increased in Norfolk at least 50% and possibly much more than that. Norfolk is a county with many silos and almost all the corn stalks, whether of sweet or field corn, are either ensiled or fed whole; so that it should not be difficult to control the borer there.

The only explanations for the increase that I can think of at present are:

First: The county grows a good deal of canning corn, much of it Golden Bantam and most of this is sown early, earlier than the field corn of the neighbouring counties. Now we know that the moths are attracted to early corn and it is just possible that many moths from the neighbouring counties flew into Norfolk and so caused the increase.

Second: Experiments conducted by Mr. Caffrey and his assistants this year in Ohio indicate that a much larger percentage of the borers hatching from the eggs survive to maturity on sweet corn than on ordinary varieties of field corn.

Third: The weather conditions in Norfolk may, without our being aware of it, have been specially favourable to the insect. I doubt very much, however, that this was a fact and am inclined to believe the first two explanations given above are the correct ones, especially as there was much sweet corn grown in the only other counties where there were noticeable increases and as most of the corn in these was planted early on account of the short season in that part of the Province. In Prince Edward county, where the increase was probably nearly as great as in Norfolk, a factor in the increase was, almost without doubt, the shallow and stony nature of the soil and so the difficulty of burying stubble completely.

From what has happened this year in Norfolk, Prince Edward and to a lesser extent in Durham and Northumberland, it looks as if it may be a very difficult task to combat the insect successfully in sweet corn areas if the corn is sown early.

Some Things That Are Needed

If we are to wage our battle against the corn borer in the most efficient and practical way there are several things that are necessary.

1. We must devote more time to supervising the work of our inspectors and making them very efficient. I think everyone realizes that the success of the Corn Borer Act depends very largely on the efficiency of the inspectors who enforce the Regulations under it.

2. We must continue the study of the most practical methods of dealing with corn fields under all conditions, and a knowledge of these methods must be passed on at once to the inspectors and corn growers. Farmers must be saved from all unnecessary labor; for the more labor required the less profit from the corn and the greater the temptation to the farmer to do poor work.

3. We need the assistance of one or more good practical experts on farm machinery. These experts must make a thorough study in the fields themselves or along with the entomologist of the way the clean-up work is now done and then try to devise better implements than we now have for the purpose, or else improve the present implements until they are satisfactory. In the United States the farm engineer has done a great deal to help; in Canada the whole task has been left to the entomologist.

4. We should have more assistance from our agronomists. I hope that ultimately we shall be able to grow any variety of corn without risk of serious damage from the insect, but for some years to come it would help us a lot, if we could substitute new varieties or hybrids on which a much smaller percentage of larvae could survive to maturity than upon our present varieties or strains. This is a problem for the agronomist, not for the entomologist.

5. Finally I should like to see a thorough study made of the effect of temperature and moisture, especially upon the moths and young larvae. At present we cannot interpret the results of our work correctly without knowing the effect of the season itself upon the insect. For instance, how does it come that in the face of a survival of over 35% of all larvae hatching from the eggs at Sandusky there was not an enormous increase of the insect in Ohio this year? Was it because there were fewer moths, or because fewer eggs were laid per female or for both reasons? More knowledge along these lines would be a great boon to the extension man and would often prevent inspectors from being disheartened by the results obtained.

Conclusion

In conclusion I may say that I feel more optimistic this year about the prospects for success in our fight against the Corn Borer both in Canada and the United States than I have felt at any previous time, but even yet I feel it is not safe to count our chickens.

DISCUSSION

Dr. Detwiler.—In the matter of control what practical value would it be to know the effect of moisture and temperature?

Prof. Caesar.—It would help to explain why one year we failed to make progress and another year succeeded better than our expectations. This would mean that the inspector would not be discouraged by what otherwise to him might look like useless effort. The farmers too would learn through the inspector or through articles in the press what to expect.

Dr. Detwiler.—Comparing the two methods of control—biological and mechanical—which would you stress for the future?

Prof. Caesar.—The mechanical method by all means. I believe we must look to improved farm practices and improved farm machinery for control. I hope that parasites will also play a part some day, but even in Europe they have to rely upon mechanical method.

A METHOD OF PREPARING WAX ENTOMOLOGICAL EXHIBITS

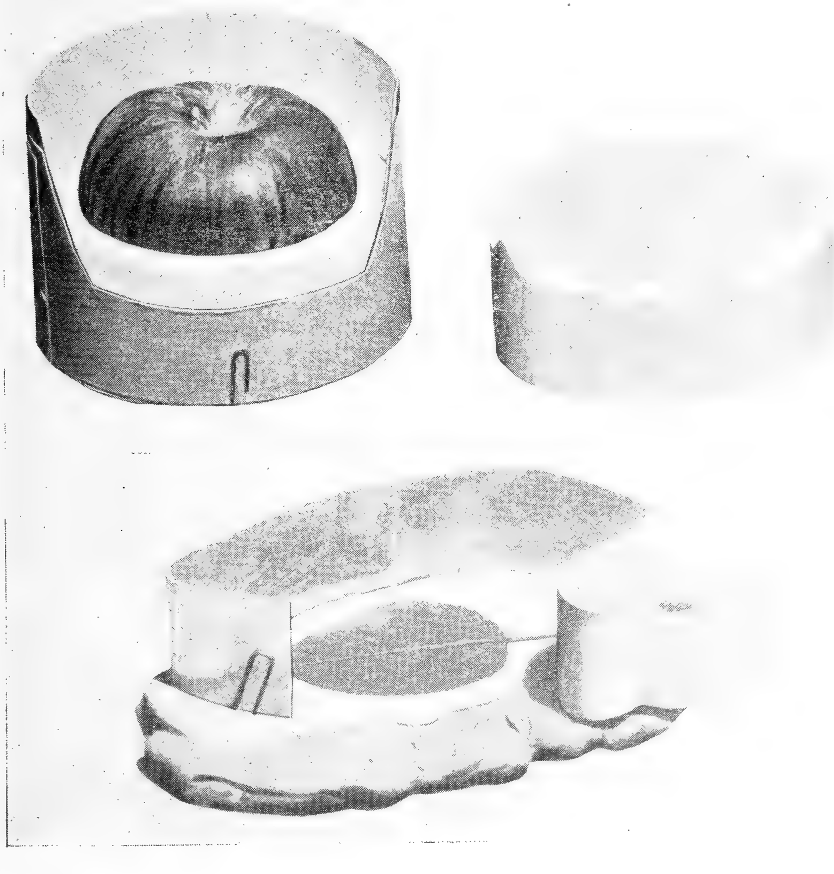
A. A. Wood, Dominion Entomological Branch, Strathroy, Ontario

The preparation of entomological exhibition material has always been attended with more or less uncertainty and unsatisfactory results. Great difficulty is usually encountered with the preservation of foliage, fruit and the larval stages of insects, but the method under discussion obviates the necessity of retaining the original specimens. Other processes are frequently used in the making of moulds from difficult subjects. Gelatin or agar-agar prove very successful if skilfully treated, only one or two casts, however, may be taken from this type of mould as the hot wax destroys the detail.

In this method plaster moulds are formed from the insects and injured host plants, in which wax "positives" are cast from these plaster "negatives." The results obtained are really much more convincing than

the dried or otherwise preserved natural material. Cases containing material prepared by this method should last indefinitely.

The construction of plaster moulds from simple objects is not difficult; some of the elementary details will be described. Oiled or waxed cardboard may be used as a "form" to hold the plaster mould. A strip of suitable size is made into a short cylinder, by joining the ends with paper clips, and pinned to a base with insect pins. The join can be sealed by running a little wet plaster around the bottom outside. A good grade builders' plaster-of-Paris will be found quite satisfactory for the majority of uses. In mixing, water is placed in the mixing bowl and plaster sifted slowly into it until a one-sixteenth inch film of water remains on top of the plaster; it is then stirred carefully to avoid air bubbles which will cause imperfect moulds. Pour immediately, filling the form about one-half full.



Above: plaster of Paris mould form and mould showing upper negative with "keys". Below: modelling clay and tin mould form with leaf in situ for making impression.

Most small subjects such as fruit and larvae may be floated in the plaster, and forced down exactly one-half way. Care must be taken to judge the "undercuts" correctly, otherwise the specimen will lock in the mould. After the plaster has heated, which will be in about twenty minutes, remove the form and shave the top of the mould smooth. Cut four "keys" in the outside edge, this number usually proves the most efficient. These are V-shaped notches cut in the plaster to a depth of about three-eighths of an inch, for a medium-sized mould. The whole surface of this first half of the mould where it will come in contact with the second "pour" should be well treated with a "separator." Many mediums may be employed but lard oil will be found easy to manage and very successful for this use. The oil is applied liberally with a brush, going over the surface repeatedly until no more oil is absorbed. A new form is now placed around the mould and the second "pour" made. When this pouring of plaster has set, remove the form and tap sharply on the join with a wooden mallet; the mould should then separate readily.

Treatment of leaf moulds is slightly different; modelling clay is used as a base which is built up to conform with the natural shape of the underside of the leaf. The leaf is then pressed gently on to the clay, being careful that the edge adheres perfectly. For a form, in this case, sheet lead or tin is shaped the proper size to encircle the leaf, is pressed into the clay and from this point one proceeds in the same manner as for a regular mould described above.

Before "casting," the mould must be thoroughly dried, then slowly boiled in stearin wax to fill the pores of the plaster. To insure success in "casting," close attention must be given at all points of the operation, as there are many conditions which if not properly carried out will mean certain failure. Temperature is of very great importance, the room temperature should be about 85° F. A usual test is to place the moulds against the face, where they should feel just slightly warm. Too hot a mould will cause the wax to stick, and if too cool, they will make imperfect impressions. Only pure refined bees' wax is used for casting, paraffin is too soft and very unsatisfactory, even bees' wax must be hardened by the addition of Canada balsam. Better results are obtained by tinting the wax before casting, this is done by the use of oil colours. Lard oil is applied to the mould as a "separator" and the wax poured at 70° C.

Larval and very small moulds are filled solid, but with any large subject such as an apple or peach a hollow cast is much more natural as it allows some transfusion of light. To obtain this type of cast fill one half and rotate the mould in the hands until the wax has set. The time for this varies according to the amount of wax in the mould; while there is any liquid wax remaining it can be plainly heard by shaking the mould close to the ear.

The casting of leaves is quite simple. For the midrib and petiole use copper wire which has been finely tapered by continuous dipping in and out of nitric acid. This should be wrapped thinly with absorbent cotton and placed in position on the under half of the mould, place a thin sheet of cotton over the entire lower impression and pour a small quantity of hot wax on the centre of the mould, when by quickly replacing the top with considerable pressure, a thin cast may be secured. The hot wax runs through the cotton to every detail of the impression; the wire reinforcement is enclosed and all excess wax forced out through the petiole channel and over the sides.

Some modelling is required in assembling the separate pieces after they have been cast, such as attaching leaves and fruit to branches. This work is most easily accomplished by using heated tools.

Much experimentation by the operator is needed to acquire the skill necessary to have all the details of wax work prove successful; many moulds and casts are certain to be ruined while trying for better methods The work of preparing exhibition cases at Strathroy is as yet merely in the experimental stage, but advancement is being made each year.

THE LABORATORY BREEDING OF MICROGASTER TIBIALIS Nees.

W. Elgin Steenburgh, Dominion Entomological Laboratory, Chatham, Ont.

Microgaster tibialis Nees is a small black four winged fly belonging to the family Braconidae. It is being introduced into the United States and Canada from Europe where in certain sections it plays an important role in the control of the European Corn Borer (*Pyrausta nubilalis* Hubn). In nature this parasite seeks out borers of the second and third larval instars and by the use of a short ovipositor stings them and inserts an egg in each. The egg hatches and the resulting maggot develops within the body cavity of the growing corn borer reaching maturity in the fifth larval instar. When full grown the parasite chews its way out through the side of its victim and spins a small white cocoon beside the remains. The winter is spent in this cocoon, emergence of the adults taking place the following spring.

Investigations by Mr. D. W. Jones, entomologist in charge of parasite work at the United States Corn Borer Laboratory at Arlington, Mass., indicated that this insect could be reared in the laboratory, and that such reared stock would be a valuable supplement to the liberation of this species from imported material. The Canadian breeding work was initiated at the Chatham laboratory in March, 1927, by Mr. C. W. Smith and was continued by the writer during 1928, operations in each case being confined to the summer months.

The first requirement for this work was a constant and plentiful supply of corn borer larvae of the proper age in which the female parasite might lay her eggs. This problem was largely solved by Mr. Jones but the methods developed by him were modified to some extent by Mr. Smith and a fellow-worker Mr. L. J. Briand, who has described the technique now employed at our laboratory in a paper entitled "The Laboratory Breeding of the European Corn Borer, with Special Reference to Equipment and Cages," (Can. Ent. Vol. LXI, No. 3, March, 1929).

Parasitism of the small borers is secured in a specially constructed cage. These cages are made of wood and are eight inches high and six inches wide and fitted with a double front of waxed cheesecloth and glass. The back is left open when in use but can be closed with a screen when necessary. The larvae for parasitism are placed directly on the bottom of the cage which is covered with glass. The glass front of the cage is placed toward a window or other source of light and the waxed cheesecloth prevents the light from being too intense and diffuses it evenly. Best results are obtained with eight females in the cage and not more than four borers placed with them at one time. Both the parasite and its host are positively phototropic and gather in the lighted areas of the cage. By reducing the lighted area it is possible to concentrate the insect population and make it easier for the parasite females to find the corn borer larvae. During the past season the average life of the parasite in the oviposition cage varied between eight and twelve days, and was dependent directly upon the num-

ber of eggs laid and the length of time they were kept subjected to high temperatures and light; thus, when not in use it proved beneficial to keep them in subdued light and at a low temperature. The corn borer larvae are placed in the cage singly and are removed as soon as parasitized. These operations are performed by the use of a fine camel's hair brush and must be done with great care to prevent injury. Whenever possible it is better to handle the borers by the thin silken thread which they spin.

After the corn borer larvae have been parasitized and removed from the oviposition cage they are placed in individual vials with food material. These vials are closed with screen corks to provide ventilation. The food material in the vials is replaced after being consumed, or after it becomes unfit for food. Generally three changes of food is sufficient to rear the borer to the fifth larval instar, at which time the parasite leaves its host. Under incubator conditions this requires from eleven to sixteen days. When ready to emerge the parasite perforates the side of its host and partially crawls out. Then twisting its head back it sinks its mouth parts into the borer and sucks the remaining juices, meanwhile withdrawing the rest of its body from the borer. In about an hour the parasite has completely emerged and nothing is left of its host except the shrivelled skin and the head capsule. The parasite cocoon is fastened to these remains.

Each day the cocoons formed in the vials are removed and placed in containers which are made of two flowerpot saucers, one inverted over the other. These saucers are soaked in water for several hours before using in order that they may become thoroughly saturated with moisture. Moisture, when needed, is added to the outer surface of the top saucer, and due to the porous structure of the latter, is soon absorbed by the container. In this connection it might be stated that moisture is a very important factor and that high humidity is essential to good emergence. As the adults emerge they are removed to a storage cage from which they are available for the breeding work or for liberation in the field. Since *Microgaster* is capable of parthenogenetic reproduction, unfertilized females producing male offspring only, it is necessary that all the breeding females be mated or the stock will become predominately male, and due to a lack of females for the oviposition cage, is soon entirely lost.

The present season's work on *Microgaster* supplemented that of the previous season and in many ways this project must still be considered in the experimental stage. During the 1927 season 2,700 cocoons were secured. Of the resulting adults 800 were liberated in an experimental plot near Chatham and the rest were used in the breeding work. In the 1928 season 2,889 cocoons were secured. A total of 1,200 adults were liberated and 670 cocoons were placed in cold storage. The cocoons placed in cold storage were secured after the liberating season was past with a view to having them available to begin the 1929 breeding work.

Unlike the ectophagous parasites, *Microgaster* presents a three-fold problem in rearing, *i.e.*, that of securing a suitable food for the corn borer larvae; rearing the host material before and after parasitism, and the problems connected with the actual rearing of the parasite.

Experimenting with various food has been an important part of the work. Many patented and dried foods, and most of the plants recorded as Canadian host plants of the European corn borer were tried in an effort to secure a food which would keep well and produce a rapid growth of the larvae in the incubator. Of the foods tested, curled dock proved the most desirable when secured fresh and the mortality was much less than with any other food used. The leaves offer ideal food for rearing the newly hatched larvae and the stalks keep well under the heavy feeding of the older borers. Unfortunately, it is useless after fruiting occurs and

probably the most suitable arrangement for securing a constant supply of this plant would be to cultivate a plot with planting so arranged as to offer a succession of growth. Green stringless pod beans rank next to dock and are usually available for a longer season. Yellow pod beans and celery also gave fairly satisfactory results. Carefulness in technique and attention to details are some of the most important factors in the rearing of this parasite.

In addition to the advantages secured by aiding in the number of parasites liberated, artificially reared parasites possess qualities not obtained in the imported material. The stock is free from hyperparasites and cocoons may be sent directly to a district newly infested with the host insect and the adults allowed to emerge there without the danger of liberating any objectionable species. Also in the areas where only a single generation of the host material appears laboratory bred parasites offer the advantage that they may be liberated when the host is most abundant and the conditions best for the propagation and establishment of the parasite in the field.

NOTES ON MYIASIS OF THE URINARY PASSAGE CAUSED BY LARVAE OF FANNIA

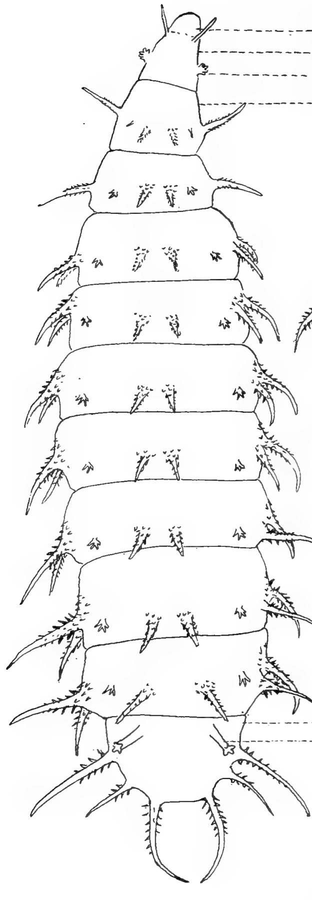
J. D. DETWILER, UNIVERSITY OF WESTERN ONTARIO, LONDON

A rather interesting case of myiasis was brought to my attention this autumn. The patient was a baby girl three years of age. It was noticed that when passing urine she made some complaint of discomfort and on examination ten or twelve parasites were found in the urine. The parents were not alarmed at the first occurrence, but when it was repeated, specimens were given to the local physician. These were submitted to the Institute of Public Health and later brought to me for identification. They were found to be the larvae of *Fannia canicularis* Linn.[1] These larvae, in common with those of the genus *Fannia,* are flattened and have very characteristic, fleshy processes along their sides. The adult fly is common in houses in both Europe and America and is sometimes known as the lesser housefly. It closely resembles the housefly, but is smaller and appears earlier in the spring. Its manner of flight is a sudden dart followed by a hovering. Its eggs are laid in decaying vegetable and animal matter and sometimes in excrement. The occasional presence of the eggs on partially decayed vegetables, etc., has been thought to account for its not uncommon cause of intestinal myiasis. The larvae, according to Hewitt (1912)[2] are about 5-6 mm. in length when full-grown and are very similar to those of the latrine fly, *Fannia scalaris* Fab. but considerably smaller. The larvae of the latrine fly also have not uncommonly caused intestinal myiasis.

Myiasis of the urinary passages, both the urethra and bladder, however, is a rather rare occurrence and may be caused by the same two. Infection is probably brought about by the flies ovipositing near the external opening of the urinary tract and the larvae working their way up into the urethra and on into the bladder.

In the case that came to my notice the child was accustomed to playing out of doors on the ground during the day and infection, no doubt, occurred then. The physician, however, could find no infection on the child which might attract the flies and reported her as having no complaints and as being normal in every respect. The passing of the larvae ceased almost immediately and she is reported as being perfectly well.

1. I am inndebted to Dr. O A. Johannsen, Cornell University, for confirmation of this determination.
2. Hewitt, C. Gordon, 1912, *Fannia* (*Homalomyia*) *canicularis* Linn. and *F. scalaris* Fab. Parasitology, Vol. V; 161-174.



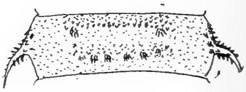


Fig. II Seg. VI
F canicularis
(Ventral aspect)

Fig. I. Larva of *Fannia canicularis*
(Dorsal aspect)

The larvae, as mentioned before, have characteristic, fleshy protuberances which are more or less spiniferous, particularly at their bases. These spines are never forked, however, as in *Fannia scalaris*. The arrangement of the protuberances may be described as follows: First, a dorsal series consisting of ten pairs and commencing with an antenna-like pair at the anterior border of the prothoracic segment (Fig. 1, Segment II). The second pair, that on segment III, is quite short but the following pairs, proceeding caudad, become increasingly longer. These protuberances, with the exception of the antenna-like pair, are distinctly spiniferous and are situated somewhat back of the middle of their respective segments. Second, a latero-dorsal series commencing on segment III and continued posteriorly. These are rather flagelliform and are also spiniferous, at least, at their bases. Third, a latero-ventral series which is similar to the series just described. The twelfth, or anal, segment is provided with three pairs of marginal flagelliform protuberances, the intermediate pair being smaller than either the anterior or posterior pair.

On the dorsal surface and near the bases of the latero-dorsal protuberances is a series of very small branched processes. These have been supposed to be of the nature of exuvial glands. On the ventral surface

there are two series of wart-like structures which may be called spiniferous papillae since they are distinctly spined. These have a rather definite arrangement; the anterior segmental papillae, a pair rather far apart, and the posterior segmental papillae, four in number, and arranged in line across the segment. Sometimes there is an indication of an extra papilla at each end of the row, making what might appear to be a row of six. The anterior segmental papillae begin on the third thoracic segment (segment IV) and occur on all of the following segments of the body. The body wall between the individual pairs tends to be somewhat spiniferous. The posterior segmental papillae occur on all of the abdominal segments except the last or anal one.

Segments II and XII each bear a pair of spiracular processes. The anterior ones (Fig. I, Ant. Spir. Pro.) are distinctly lobed and fan-like while the posterior ones (Fig. I, Post. Spir. Pro.) are tubular and rather bluntly lobed.

Four of the larvae were submitted for examination. These measured 8.02, 7.28, 6.46 and 5.86 mm. in length respectively. Two, it will be noticed, are longer than the length given by Hewitt for full-grown larvae. Some allowance might be made on account of the protruded pseudo-cephalic segment (Fig. 1, Segment I). However, specimens of this species,[1] which developed in a neglected rat cage and in which segment 1 was not protruded, measured 7 mm. in length. These are darker in colour and appear more robust than those which lived as parasites.

Discussion

Dr. Walker.—Last year there was a large number of *Fannia* larvae present among other larvae which we were rearing on decayed meat. We had also a case of internal myiasis caused by a *Fannia* larva in common with two others, one of which was probably a *Lucilia*.

THE VALUE OF TRAP CROPS IN THE CONTROL OF THE WHEAT STEM SAWFLY IN ALBERTA

H. L. Seamans, Dominion Entomological Laboratory, Lethbridge, Alberta

Introduction

The wheat stem sawfly, *Cephus cinctus*, Nort., has been gradually working into Alberta for the last ten years until it has become well established in the south central portion of the province. This is one of the best wheat growing sections of the Canadian prairies. The annual loss was very severe in 1925 and 1926, but has since been reduced by the wet seasons of the last two years.

The soil in this infested area is a very fertile, heavy, clay loam, locally known as "gumbo." The heaviest soil lies in a strip from ten to fifteen miles wide along the Red Deer river. Beyond that, it gradually becomes lighter with an increasing sand content. It absorbs and holds moisture readily and its general character makes the use of a mouldboard plough impossible. For this reason disc ploughs are used almost exclusively and the district has become known as the "disc plough area." While these ploughs will cut a deep furrow they do not invert the land as does a mouldboard plough. This results in much of the short stubble being left on top

1. Kindly given me by Mr. R. Ozburn of the Ontario Agricultural College, Guelph, Ontario.

of the soil or only partially buried, a totally inadequate condition for controlling the sawfly by the burying of the larvae or pupae in their hibernaculae in the stubble.

Mr. Norman Criddle,* of the Dominion Entomological Laboratory, Treesbank, Manitoba, has been working on wheat stem sawfly for many years. He has suggested the seeding of so-called "immune crops" such as oats, barley or brome grass which are not seriously injured by sawfly. He has also recommended the cutting of native grasses or specially seeded strips of wheat as trap crops.

Following the lead of Mr. Criddle, and because of the possibility of a control by the use of a disc plough, particular attention has been given to the value of trap crops in the disc plough area.

Emergence and Oviposition of the Sawfly

The emergence of adult sawflies is dependent on weather conditions so that the date of first emergence varies with the season. In 1926, the first adults appeared on May 22 but the next season they were a month later. In 1928 the first adults appeared on June 8. Oviposition starts within a day or two after the females emerge.

Careful observations have been made on oviposition to determine the type of plant most attractive to the females. Here the findings coincide with those of Mr. Criddle. The females invariably choose stems which are well developed and hollow though still succulent. There is apparently no discrimination between species of grasses or grass-like plants provided the stem is sufficiently large to harbor the larvae and has reached a stage in development where some portion of the stem is hollow. This is determined by the female tapping the stem with her antennae until a suitable location for oviposition is found. The average stem chosen of grass or grain, is one which is either headed out, or has the head well up in the "boot." These conclusions are based not only on the observations of the females actually ovipositing but the examination of hundreds of stems for the purpose of finding and counting the eggs or young larvae present.

Several eggs may be laid in a single stem. The first larva to hatch proceeds to destroy the rest of the eggs in that portion of the stem before feeding on the plant or boring through the node. One stem may contain several freshly hatched larvae but only one will survive to maturity. The number of eggs or very young larvae which have been in a single stem indicates the desirability of the stem for oviposition. This then becomes an index of the value of that stem as a trap.

The Relation Between the Development of the Sawfly and its Host Plant

There is no doubt that the conditions which induce the emergence of sawfly adults are ideal for the development of the host plants. For the past three seasons, the first appearance of adult sawflies has been preceded two or three days by the first appearance of heads of *Bromus inermis* Leyss., *Agropyron smithii* Rydb., winter wheat, winter rye and volunteer spring wheat. This means that the majority of the stems of these plants have developed far enough to be most suitable for oviposition by the time the females emerge. On the other hand the earliest seeded spring wheat in these seasons has not been developed sufficiently to be suitable for oviposition until after the majority of the sawflies have started to lay.

*Mr. Norman Criddle, of the Entomological Branch has been of great assistance in this project. His personal advice, experience and criticism, as well as his publications have been used extensively in carrying out the work and have been greatly appreciated.

The earliest seeded oats have come into the "boot" during the height of flight but these were seeded before the wheat. The result has been that the perennials or the plants which made some growth the fall before have received all the early eggs and the majority of the later ones.

The first species of grass or grain to produce "hollow" stems each spring has been brome grass (*Bromus inermis* Leyss.) This grass is invariably a few days ahead of *Agropyron* or any of the grains. Winter rye is the first of the grains to head out but it is only a day or two ahead of winter wheat. Volunteer spring wheat varies according to the start the plant has made the previous fall but the earliest heads are a few days later than winter wheat.

In order to show the distribution of infestation in different plants a field was selected which contained most of them. This field had produced a crop of wheat the previous year and with no cultural preparation whatever a crop was drilled into the stubble early in the season of 1927. The moisture condition was ideal so that a heavy and early growth resulted.

The following table gives the results of the examination of such plants as were found in this field towards the end of the oviposition period. The table clearly indicates the index of trap crop value of these plants.

Host plant	Per cent infested	Average No. of eggs per inf. stem	Average No. of larva per inf. stem
Bromus inermis	100	0	3.9
Agroypron smithii	100	1.5	1.5
Volunteer sp. wheat (most advanced stems selected)	100	1.6	2.3
Volunteer sp. wheat (ave. stems)	91	2.7	.8
Volunteer rye (winter)	100	1.0	3.0
Stipa viridula	100	.2	2.4
Crop wheat (only most adv. stems)	50	1.2	.6

At the time these observations were made very few eggs were being laid. Practically every internode in the stems of *Bromus* contained a larva which would destroy new eggs in a very short time. The average number of eggs per stem indicates how recently those stems began to be favorable for oviposition, especially when the average number of larvae per stem is low.

Unfortunately there were no oats or wild oats in the field for direct comparison, but these were growing a short distance away across a road. The wild oats were more advanced than the cultivated plants and these stems were 90 per cent. infested with an average of 1.7 larvae per stem. The most advanced stems of cultivated oats were only 50 per cent. infested with an average of four eggs per stem, none of which had hatched. These were seeded after the wheat and were not intended as a trap crop.

Plants to be Used as Trap Crops

Any of the grains or grasses can be used as a trap crop provided they are sufficiently developed at the time of sawfly oviposition. Their practical value depends on the following points:

(1) Attractiveness to the female sawflies.
(2) The possibility of actual control of the sawfly by preventing the larvae from maturing.
(3) The cost of the trap crop.
(4) The actual value of the trap crop.
(5) The value of the crop to be protected.

The attractiveness of possible trap crop plants to the ovipositing female sawflies has already been discussed.

Mr. Criddle has pointed out that very few larvae mature in oats or brome grass. These crops can be used as a trap and grown for either hay or seed. On the other hand, the larvae will mature in either spring wheat or native grasses. When these are used as a trap they must be cut for hay and the cutting must be done before the larvae have descended to the base of the stem. If the cutting is delayed and the larvae have descended far enough to be left in the stubble, the large majority of them will mature.

The first cost of the trap crop for all the plants except native grasses is the seeding. Brome grass when once seeded, becomes a permanent trap and this cost is eliminated after the first year. Wheat and oats must be seeded each year and the seeding must be done early enough so that the plants will develop sufficient stem to be attractive to the female sawflies. If this seeding is delayed until all the spring cultivation is finished the trap will not have sufficient time to make the necessary growth. On the other hand, if the seeding be followed by a short period of excessive drought, as was the case this (1928) spring, the trap crop is still later than the perennial grasses.

Where wheat and oats are being used for trap crops the question of cost of seeding is a complicated one. Many of the farmers in the "disc plough area" are growing registered grain, and the practice is becoming more general throughout the Canadian prairies each year.

This requires extra care to prevent the mixing of wheat strains. The result is a better yield and a more valuable crop. Since registered wheat is sold for seed the price per bushel is higher and is not affected by the grades as is milling wheat. The use of seeded wheat for a trap crop would mean using a high priced seed to eliminate the risk of mixing strains or extra care in removing the trap crop. Most farmers cannot afford to use registered seed to grow a crop that is to be cut for hay, and a slight delay in cutting a trap crop of inferior wheat might cause the field to be rejected for registration. A field may also be rejected because of the presence of wild oats, and such contamination can easily occur if ordinary oats are used as a trap crop. For this reason it is advisable to use registered oats for a trap crop, and the cost of the seed is greater.

The second cost of the trap crop is the cutting. Both wheat and native grasses must be cut before the larvae have matured, usually by the middle of July. This usually requires a labor outlay at a time when it is not always convenient and the crops can only be used for hay. Brome grass and oats can be cut for hay or left for seed to suit the convenience and needs of the farmer.

The actual value of the trap crop depends on the season. If the season is dry, hay will have a greater value than when there is enough moisture to produce an abundance of it. In a dry season, native grasses seldom produce sufficient growth to make cutting profitable and often the yield is so small that it cannot even be gathered. This means a loss of the trap crop and the cost of cutting it. In this type of season wheat hay will have greater value because of the possible shortage but not enough to pay the cost of the high priced seed.

A trap crop of oats has greater possibilities for producing returns than any other. A paying crop of hay can be grown in any season and oat hay is more valuable than wheat. There is no need of cutting the trap for hay if grain is more to be desired and a trap seeded with registered oats will give a substantial return in seed.

*The writer wishes to express his thanks to Mr. P. J. Rock of Morrin, Alberta, for his assistance and co-operation in the project. Mr. Rock is a grower of registered wheat and oats and has allowed his farm to be used as a headquarters for experimental work.

The value of the trap crop to be protected depends largely on whether the farmer is producing registered grain or growing milling wheat. When special strains of wheat are being grown which will ultimately sell for registered seed it is obvious that a greater expense can be incurred for protection than in the growing of ordinary wheat. Registered wheat will sell for three or four times as much as milling wheat, and either is more valuable than a foul crop that may be grown for hay.

How the Trap Crop is Used

Brome grass is perhaps the ideal trap crop. Besides acting as a positive control, since few larvae mature in the stems, it is attractive to the females during the entire flight period. It makes a good growth under practically all seasonal variations and when once started it requires no attention. It can be cut for hay, used as a pasture, threshed for seed or left entirely alone. A strip of brome grass seeded around a field, along the roadside or in an adjacent field for pasture or hay, will last for several years. The only drawback is that it requires a season's growth before it is vigorous enough to be effective, but if seeded with oats as a nurse crop the oats will suffice as a trap for this first season. Brome grass seeded along a roadside or fence line is also an excellent control for many noxious weeds.

Most of the wheat in the province is seeded on land which has been summer fallowed the previous season. This means that the sawfly must come in from the outside and that the heaviest infestation occurs on the edges of the field. In order to protect the crop that is being sown on summer fallowed land it is only necessary to sow the trap around the edge of the field. The experience of the last three seasons indicates that this border need only be two or three rods wide to protect a field of one hundred acres. If there is a large area of wheat stubble adjacent to the field it is wise to use a three rod strip on that side, but if the area is bounded by oat stubble or native grass a two rod border is sufficient. Where brome grass is used for a permanent trap a border two rods wide is sufficient. If a brome grass pasture or hay meadow is next to the field to be protected there is no necessity of any other trap crop on that side, even though there may be a ten or twenty foot strip of native grass separating the two fields.

It is very difficult to protect a field that is cropped to wheat for two or three years in succession. In such fields the infestation becomes general throughout and the loss is correspondingly heavy. A brome grass or oat trap crop around the outside will aid in preventing the spread to surrounding fields and will reduce the numbers to some extent but it is much better to abandon the successive wheat cropping and to seed the entire field to oats very early in the season. If such a field is summer fallowed the insects are forced to other fields unless the cultivation is delayed until oviposition is over. The delay in cultivation allows the volunteer wheat and grass in the field to act as a trap crop and the larvae are killed when this volunteer growth is destroyed by cultivation.

Practical Results from Trap Crops

Trap crops have been carefully observed during the past three seasons. Both brome grass and oats have been used to protect fields of from 80 to 120 acres. Periodic examinations of the trap and the protected crop have been made to determine the infestation in each.

A permanent brome grass trap crop was seeded along a road. On either side of the road were fields which had been seeded to registered marquis wheat and summer fallowed alternately. For several years the sawflies have migrated across this road from the stubble in the field that

was being summer fallowed into the new crop on the other side. The trap crop now consists of two eighteen foot strips with the road between them. In 1927 the brome grass was 96 per cent. infested next to the summer fallow and 60 per cent infested next to the growing crop. The outside row of wheat next to the trap had 10.5 per cent. of the stems infested. Ten feet into the field the infestation dropped to 7 per cent., and 40 feet in there was no infestation.

On the opposite side of this field there was also wheat stubble being summer fallowed but no trap crop. The first two rows of wheat on this side of the field were 3.7 per cent. infested. Ten feet into the field the infestation was 44 per cent.; fifty feet from the edge there were 17.9 per cent. of the stem which contained sawfly larvae, and 80 feet in from the edge the infestation was still 9.6 per cent.

The next season (1928) the condition was reversed. The wheat stubble referred to above being summer fallowed and the other two fields seeded to wheat. The examination of the brome grass trap showed 88.5 per cent. of the stems infested next to the summer fallow and only 50 per cent. infested next to the wheat across the road. The first row of wheat next to the brome grass was entirely free from infestation and no signs of sawfly were found farther into the field. The upper end of this field, beyond the trap crop, was 11 per cent. infested for at least ten feet in from the edge.

On the other side of the summer fallow, registered marquis wheat was seeded without a protecting trap crop. The infestation for the first 40 feet into the field averaged 15.5 per cent. The opposite side of this same field was protected by a trap crop 100 feet wide of registered oats while the two ends were bordered with native grass. The two ends averaged 11 per cent. infested stems while along the oats the infestation was less than 5 per cent., and did not extend into the field beyond the second row of wheat. The oat trap crop was placed on that one side because a field of wheat across the road had been continuously cropped for three years and was to be summer fallowed in 1928. The native grass along the road was close to 100 per cent. infested and the oats were swarming with ovipositing sawflies early in the season.

Similar conditions exist on other farms in the district and a careful examination of the crops has given almost identical results. Brome grass pastures and hay fields have proven as efficient as the roadside trap described. More attention has been paid to the latter because of its location between two fields which are being cropped and summer fallowed on alternate years. Many other trap crops of oats have been observed and when seeded early enough these have given results comparable to the one mentioned. When seeded later than the wheat, the oats as trap crops have proven useless.

Conclusions

In view of the type of soil in the "disc plough area" of Alberta it is impractical to attempt to control the wheat stem sawfly by cultural methods. The trap crop appears at present to be the best solution of the problem and of the various trap crop possibilities oats and brome grass are best adapted to the agriculture of the region. The results of three season's work indicate that a permanent trap crop of brome grass can be used as a protection for any field without requiring special attention. It has the additional advantage of yielding a paying crop of hay or seed and controlling weeds.

Oats should only be used as a trap crop when it is needed at once. In order for an oat crop to be efficient in controlling sawfly it should be seeded earlier than the wheat to be protected.

NOTES ON THE LIFE HISTORY OF THE ORIENTAL PEACH MOTH AT VINELAND STATION

THOS. ARMSTRONG, DOMINION ENTOMOLOGICAL LABORATORY, VINELAND STATION, ONT.

INTRODUCTION

The oriental peach moth so far as known has been present on this continent from about 1913, when it was supposed to have been introduced from Japan. From the time of its introduction the insect has spread rapidly and extensively until the area of infestation today includes practically all of the peach growing areas in the Eastern United States and Canada. The moth was discovered in the peach belt of Ontario in the fall of 1925, and since that time has caused serious injury to the peach crop.

For the past three years a study has been made of the bionomics and life history of the pest. The information in this paper is based entirely on observations made during 1926, 1927, and the spring of 1928.

LIFE CYCLE AND ACTIVITIES

Like its relative the codling moth, this peach insect passes the winter as a full-grown larva spun up in a cocoon. Pupation starts early in the spring and is followed by the appearance of the spring generation of moths in May and June. Throughout the summer there is a succession of generations until the third generation of larvae is reached. Practically all of these third generation larvae fail to pupate, and after making their cocoons, work ceases until the following year.

Activity commences very early in the season and continues until a late date in the fall. For instance, pupation of overwintering larvae started on March 17, in 1927, with the first adult appearing during the first week of May, when the peach trees had a terminal shoot growth of only one-quarter to half an inch, and the blossom buds were still unbroken. Mature larvae continued to emerge from apples in the insectary as late as December 14, and eggs were deposited as late as October 28.

THE EGG

DESCRIPTION AND LOCATION.—The eggs are small, grayish-white in colour, and round or slightly oval in outline when viewed from above. They are found singly on the upper or lower surface of the peach leaves, on the petioles and on the shoots, most eggs being laid on the under sides of the foliage.

PERIOD OF INCUBATION.—The duration of the incubation period varies considerably. In 1927, some eggs took as few as 4 days to hatch, while others required 34 days. The first eggs laid in the spring hatched in 17 days, and as higher temperatures were recorded the incubation period became shorter and shorter. In the autumn the opposite takes place, for, with the advent of colder days, the eggs require longer periods for embryonic development. The average incubation period for 316 first generation eggs, in 1927, was 9.6 days; for 1,436 eggs of the second generation. 6.4 days; and 1,044 third generation eggs averaged 8.4 days.

Table No. 1.—Incubation Periods of Eggs of the Oriental Peach Moth in 1927.

Generation	No. of Eggs	Time of Year	Incubation Period in days			Temperature (F°)		
			Max.	Min.	Ave.	Max.	Min.	Ave.
First.........	316	May 22—July 8	18	4	9.6	98.5	38	60.9
Second.......	1436	July 21—Sept. 4	9	5	6.4	88	47.5	67.3
Third........	1022	Sept. 5—Oct. 6*	10	6	8.3	94	36.5	65.2

*Eggs hatching after October 6 did not give rise to mature larvae.

The Larva

Emergence from Eggs.—Prior to leaving the egg, the whole outline of the young larva can be seen beneath the transparent chorion. When the caterpillar is ready to hatch its mandibles commence to work, gradually making a slit in the egg shell. The head is pushed out and in a very short time the process of hatching is complete.

Entering Feeding Quarters.—The small caterpillar goes to considerable trouble when making an entrance into the feeding quarters. Every mouthful it bites off is pushed to one side all around the growing cavity, and so far as observed none of this material is eaten. The mound of castings sometimes gets out of hand, so it uses silken threads to hold the discarded pieces of tissue back from the excavation.

In the peach orchard the food of the larva is either the tender shoots or the fruit. After hatching the caterpillar wanders around the leaves seemingly in search of food. If it is fortunate in finding a favourable entering place in shoot or fruit, it will at once commence to bite its way in. If a twig is chosen, the entrance is made at any point from the fifth leaf up to the growing tip. In the insectary the larvae would enter twigs at the base of the leaves, behind bracts on the stem, or directly through the growing tip. When fruit is chosen, the most common place of entry is at the stem end in the crease where the stem joins the peach. The small bracts on the stem of the fruit seem to serve as a necessary protection. If a leaf happens to be lying over a peach, the caterpillar may take advantage of this and enter from the side of the fruit which is covered by the leaf. Other favoured places at which entry into the fruit is made are through the short stem and the point where two peaches touch. When the young caterpillar works through the stem, no external sign of injury is noticed at the time of picking the fruit.

Feeding Habits.—Most of the feeding in the fruit (peach) is done in close proximity to the pit, the larvae working around the interstices, and filling the eaten-out areas with frass. Thus, when the peach is split open the feeding areas adjoining the pit are most prominent. As many as ten larvae have been taken feeding in a single peach.

In the spring and early summer the caterpillars enter the new succulent shoots. In the insectary the larvae fed and matured in peach twigs, but in no instance was a single twig sufficient for the complete feeding period of a larva. Two and even three shoots were used, all of which were mined from one to four inches from the tip. A common occurrence in the orchard is for the larva to commence its feeding in the twig and later to pass to the fruit. On completion of the feeding, the mature caterpillar leaves the fruit or shoot and seeks a suitable location for cocooning.

Length of Feeding Period.—The feeding period of the larva is influenced largely by the prevailing temperature. In 1927, larvae matured in as few as 10 days while it took 73 days for one larva to complete its feeding. The following short table shows the length of the feeding periods for the different broods, correlated with the average daily temperature throughout the span of each generation. Considering the first and second broods, it will be noticed that there is a slight increase in the length of the average feeding period of the second brood larvae, correlated with a slight drop in the daily mean temperature. The third generation shows a decided increase in the length of the feeding period, and coupled with this increase is a very much lower average temperature.

Generation	No. of larvae	Span of Feeding Period	Feeding Period in days			Daily Mean Temperature
			Max.	Min.	Ave.	
First	258	June 8—July 27	34	11	18.8	66.62
Second	1436	July 27—Oct. 3	34	10	20.0	66.32
Third	1022	Sept. 12—Dec. 14	73	17	40.0	49.9

Cocooning.—When full grown, larvae leave the shoots or fruit and wander around in search of a place to spin their cocoons and later to pupate. During the summer cocoons are formed at the junctions of the twigs; on the fruit along the crease; at the attachment of the fruit to the stem; or in the cavity of the peach where the stem is attached. Another favorite place is at the point where two peaches touch. Overwintering larvae build their more substantial cocoons behind the rough bark of the trees; on the ground in the stubble and refuse at the base of the trees; and in the cracks and crevices of the peach containers. A few have been observed hibernating in the upper parts of the tree on the twigs, usually behind fruit spurs.

Mortality of the Winter Brood of Larvae.—A considerable number of larvae in the rearing vials kept in bands around trees all winter have died. This loss has also occurred with the caterpillars overwintering in their normal locations on the ground and behind the rough bark of the trees. The table below gives the actual losses in 1927 and 1928.

Year	No. of Hibernating Larvae	Location	Adults Emerging	Loss
1927	774	In vials	281	62.4%
1928	1592	In vials	855	46.3%
1928	1351	In cages	596	55.9%

It would appear, therefore, that approximately 50 per cent. of the larvae are lost due to winter conditions.

In the late fall of 1927, larvae were taken as they matured in apples, and placed in jars containing broken bark or corrugated paper. This material was kept in the insectary in order to secure records of the spring emergence. It would appear that the latest maturing larvae show the greatest mortality, although caterpillars maturing as late as the end of November may survive. Fifteen larvae maturing in December, and the last to appear from fruit, did not give rise to adults.

Table 2.—Mortality of Late Maturing overwintering Larvae.

Date Larvae Matured, 1927	No. of Larvae	No. of Adults Emerging, 1928	Per Cent. Emergence	Per Cent. Mortality
November 1	64	52	81.3	18.7
" 2	68	50	73.5	26.5
" 2	37	31	83.8	16.2
" 4	29	26	89.7	10.3
" 7–11	27	20	74.1	25.9
" 12	71	47	66.2	33.8
" 14–15	46	25	54.4	45.6
" 16	61	35	57.4	42.6
" 17	17	9	59.8	41.2
" 21–23	49	22	45.0	55.0
" 24–26	15	8	53.3	46.7
" 27	35	3	8.6	91.4
" 29–30	24	2	8.3	91.7
December 1–14	15	0	0	100.0

The Pupa

After maturing the larva takes on the average from 4 to 8 days to find a suitable place, and to spin a cocoon, before actually pupating. In one or two instances as many as 22 days have elapsed before pupation occurred.

Duration of the Pupal Period.—There is a considerable variation in the length of the pupal period, depending on the time of year pupation takes place. The maximum in 1927 was 61 days, while the minimum was 9 days. The average duration for summer pupae is from 12 to 14 days, and 268 pupae of the overwintering generation took, on the average, 34 days before transforming into adults. (Table No. 3)

Table No. 3—Length of the Pupal Period Throughout the Season of 1927.

Generation	No. of Pupae	Time of Year	Pupal Period Days			Temperature (°F.)		
			Max.	Min.	Ave.	Max.	Min.	Ave.
Over winter..	268	Mar. 17—June 23	61	20	34.2	83	21	48.4
First.........	563	July 3—Aug. 23	18	9	12.5	96	46	68.3
Second.......	1370	Aug. 17—Nov. 1	31	9	14.0	94	34	61.2

The Adult

Presence in Orchard.—Moths are present in the orchard from the first emergence in the spring until the late fall, at which time the heavy frosts kill them. There may be a slight break, when no moths are to be found, between the overwintering and first generations, but this seems to be the only break likely to occur.

Spring Emergence.—In 1926, 774 overwintering larvae kept in vials and vial-bands around pear trees, gave rise the next spring to 281 moths, which emerged over a period of a little over a month and a half, commencing on May 6. The spring emergence in 1928, commenced on the same date as 1927, May 6, and continued for two months. The last spring generation moth appeared on July 4. This material was kept under the

same conditions as the 1926-27 larvae. Caterpillars which have spent the winter in storage, or in other sheltered locations emerge later than the larvae located in the open. Emergence continued until July 30, in storage, at Vineland Station in 1928. The table below shows the time of emergence of moths of the overwintering generation, in 1928. All of this material was kept under outdoor conditions. (Table No. 4).

At the time of maximum emergence of the spring generation in 1927, the Elberta peach trees were in blossom with about 50 per cent. of the petals off, and the new terminal twig growth was from two to four inches in length. Thus the moths emerging at this time had plenty of egg-laying sites and the resulting larvae large numbers of succulent new shoots in which to feed. The growth in 1928 was not so far advanced as that of the previous year, at the time of maximum emergence of spring brood moths. On May 18, Elberta trees showed a terminal shoot growth of one to two inches, and the trees were just beyond full bloom.

Table No. 4—Emergence of Overwintering Generation Moths at Vineland Station in 1928.

Date of Emergence	No. of Moths	Males	Fem.	Date of Emergence	No. of Moths	Males	Fem.
May 6	7	7	0	May 29	19	11	8
" 7	12	9	3	" 30	40	22	18
" 8	10	7	3	" 31	30	17	13
" 9	12	10	2	June 1	17	5	12
" 10	38	25	13	" 2	9	3	6
" 11	13	12	1	" 3	8	3	5
" 12	24	17	7	" 4	3	2	1
" 13	47	23	24	" 6	2	1	1
" 14	58	36	22	" 7	25	10	15
" 15	52	30	22	" 8	7	2	5
" 16	2	2	0	" 9	9	5	4
" 17	2	2	0	" 10	9	2	7
" 18	13	8	5	" 11	15	5	10
" 19	43	24	19	" 12	3	0	3
" 20	55	31	24	" 13	7	2	5
" 21	93	47	46	" 14	6	0	6
" 22	39	23	16	" 15	1	0	1
" 23	13	6	7	" 18	2	0	2
" 24	42	24	18	" 21	3	0	3
" 25	25	17	8	" 22	1	0	1
" 26	9	7	2	July 2	2	0	2
" 27	10	7	3	" 4	1	0	1
" 28	12	4	8				

Total number of moths.....................850.
Percentage of Males........................55.
Percentage of Females......................45.
First emergence............................May 6.
Last emergence.............................July 4.
Maximum emergence..........................May 21.

ACTIVITY AND LENGTH OF LIFE.—Both male and female moths are active during the warm days, and especially so from about noon until after sunset. On cold days, at temperatures below 60 degrees, they are very inactive, resting for the most part on the foliage and stems.

The length of life of moths is influenced to a certain extent by the weather conditions. Cold weather, which causes inactivity, brings about a lengthening in the life of the moth, while days of high temperatures tend to shorten its life. During the mid-summer the average length of life of 78 females was 17 days, and for 83 males, 15 days. Later, when cooler weather

prevailed, the average life for 38 females was 21 days and for 40 males, 19 days. One male moth lived for 43 days during the late fall. All of these moths were kept in cages in the insectary. (Table No. 5).

Table No. 5—The Length of Life of Moths in Cages in the Insectary, in 1927.

Generation	No. of Males	No. of Females	Length of life in days			Aver. for Females
			Max.	Min.	Aver. for males	
Over winter........	92	71	32	2	14.1	16.9
First...............	83	78	34	2	15.0	16.9
Second.............	40	38	43	8	19.2	21.4

Pre-oviposition Period.—The pre-oviposition period varied throughout the season of 1927 from one to 14 days. The average for 46 overwintering generation moths was 6.7 days; that for 52 first generation females, 1.75 days; and for 26 second generation moths, 2.5 days.

Process of Egg-Laying.—The actual process of egg-laying is one of considerable rapidity. The moth is flying vigorously at the time in short flights, in a nervous manner. It flutters around the foliage, suddenly alights, and placing the abdomen and ovipositor in position, deposits the egg. The whole process is completed before the observer realizes that an egg is laid.

Time of Egg-Laying.—The females lay their eggs in the late afternoon and early evening. It would appear that from two hours before until two hours after sundown all the eggs are deposited for the day. Two separate days observations are given to show when the eggs were deposited on peach foliage placed in a cage in the insectary. The cage contained about 50 moths.

Day No. 1.—A hot sunny day throughout. Average Temperature 82.2.

Time of egg deposition.	No. of eggs.
9 a.m. to 5 p.m.	0
5 p.m. to 6.35 p.m.	9
6.35 p.m. to 8.20 p.m.	115
8.20 p.m. to 9 a.m. (next day)	15
Total number of eggs laid	139

Sunset, 7.40 p.m.

Day No. 2.—A hot day. Sun went behind clouds at 5.15 p.m., and did not shine again. Rain fell about 6.30 p.m. for a time and again at 8.30 p.m. quite heavily. Average temperature, 82.3 degrees.

Time of egg deposition.	No. of eggs.
9.00 a.m. to 5.30 p.m.	4
5.30 p.m. to 6.30 p.m.	53
6.30 p.m. to 7.30 p.m.	10
7.30 p.m. to 8.30 p.m.	1
8.30 p.m. to 8.30 a.m (next day)	0
Total number of eggs laid	68

Sunset, 7.40 p.m.

Females laid throughout periods varying from 3 to 27 days.

The average period of oviposition determined from 52 first brood females kept in cages in the insectary, was 14 days.

Such factors as a sudden drop in temperature, dull weather, rain and high winds no doubt play a part in determining the time the eggs are laid as well as the number to be deposited for the day.

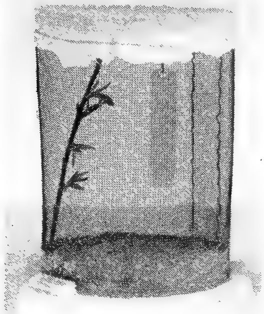


Fig. 1—Wire Screen Oviposition Cage

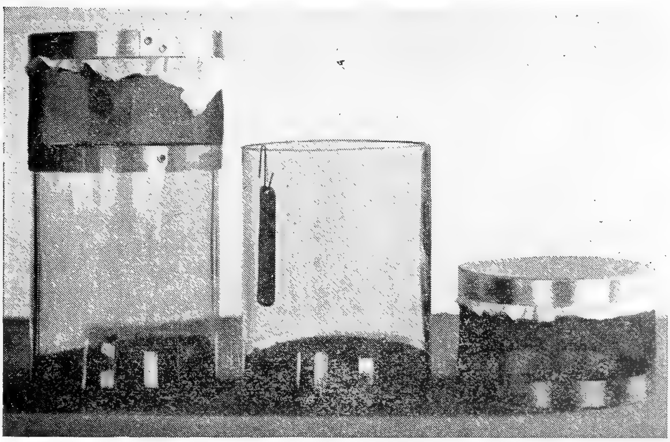


Fig. 2—Improved Battery Jar Oviposition Cage

Figures 1 and 2 illustrate the types of oviposition cages used in the insectary for the egg-laying experiments. The wire screen cage (Fig. 1) has proved to be the best type, permitting free air circulation, and more natural conditions.

FECUNDITY.—In order to secure information on the number of eggs laid by females, cages like those shown in the illustrations were used in the insectary. Two and three female moths were used in each cage with a similar number of males. The table below gives the results secured along with the average daily temperature throughout the oviposition period for each generation of moths. It will be noted that the females laid best at

the higher temperatures. The greatest number of eggs laid by any one female was 136.

Generation	No. of Females	Time of Year	Total No. Eggs	Aver. No. per Fem.	Mean Temp. for Period
Over winter........	46	May 22—June 27	1418	31	53.1
First..............	52	July 18—Aug. 29	2991	58	67.2
Second............	26	Sept. 8—Oct. 27	1376	53	59.5

Host Plants

Larvae of the oriental peach moth have been successfully reared under insectary conditions in peach, apple, pear, plum, quince, apricot, nectarine, cherry, and Japanese quince fruit, and in peach and apple twigs. In the orchard they have been taken in peach, quince, apple and pear fruits, and peach shoots.

Generations

For the past two years, three broods of larvae have been reared in the insectary. What we have termed the overwintering generation, commences with the larvae which have spent the winter in their cocoons, and closes when the last moth emerges from this material. The first generation starts with the first eggs laid in the spring. These eggs give rise to larvae which are responsible for the first injury in the orchard. This first generation is complete. A second generation follows, which in turn gives rise to a third. The span of the various generations is given in the table below. It will be noted that a considerable amount of overlapping exists, and it can be readily observed that the insect is working in the orchard from early spring until fall without a break. Practically all of the third generation mature larvae hibernate. In fact, in 1927, not a single third generation caterpillar pupated.

Generation	1926 Time of Year	1927 Time of Year
Overwintering...........	April 24* to June 22	March 17 to June 23
First....................	June 8 to Aug. 17	May 22 to Aug. 23
Second.................	July 28 to Nov. 14	July 20 to Nov. 1
Third....................	Aug. 26 to Nov. 22	Sept. 5 to Dec. 14

*Notes taken on 30 individuals only.

PARASITISM OF THE ORIENTAL PEACH MOTH IN ONTARIO WITH SPECIAL REFERENCE TO BIOLOGICAL CONTROL EXPERIMENTS WITH *Trichogramma minutum* Riley

C. W. Smith, Entomological Laboratory, Chatham, Ont.

Introduction

The oriental peach moth (*Laspeyresia molesta* Busck) was discovered in the Niagara peninsula of Ontario in the autumn of 1925, its abundance and distribution at that time indicating that it had probably been introduced in the neighbourhood of St. Davids some two or three years previously. It has increased and spread very rapidly and is now found through-

out the peach growing sections of the peninsula. The St. Davids district, however, has continued the centre of heaviest infestation and practically all investigational and control operations have been confined to this district on account of the difficulty of securing material in sufficient quantities for study elsewhere. Another very serious infestation has developed in the southwestern peninsula, but this has not been included in the studies further than to determine the extent and degree of infestation.

Investigations in the United States have shown that in newly invaded territory parasites do not assume an important role in the control during the first two or three years, or until the host has become quite abundant. In Ontario the parasite situation was not made the subject of special study until the present year, but in the course of life-history and control investigations carried on during 1926 and 1927 by Mr. W. A. Ross and his associates all parasites encountered were carefully noted and preserved for identification. The material thus secured contained nine species of hymenopterous parasites, but the total number of specimens was so small as to indicate a negligible parasitism. During the present season a series of experiments were conducted at St. Davids with a view of determining the possibility of utilizing the egg parasite *Trichogramma minutum* Riley in the biological control of the peach moth, and the general technique employed together with the results obtained are given briefly later in this paper. In connection with this study a great deal of information was secured on the natural egg parasitism by *Trichogramma* and through the courtesy and assistance of various members of the staff of the Vineland Entomological Laboratory some data were secured on parasites attacking the larval and pupal stages of the pest as well. This information is presented herewith as indicating the probable status of the parasites as a factor in the control of the pest at the present time.

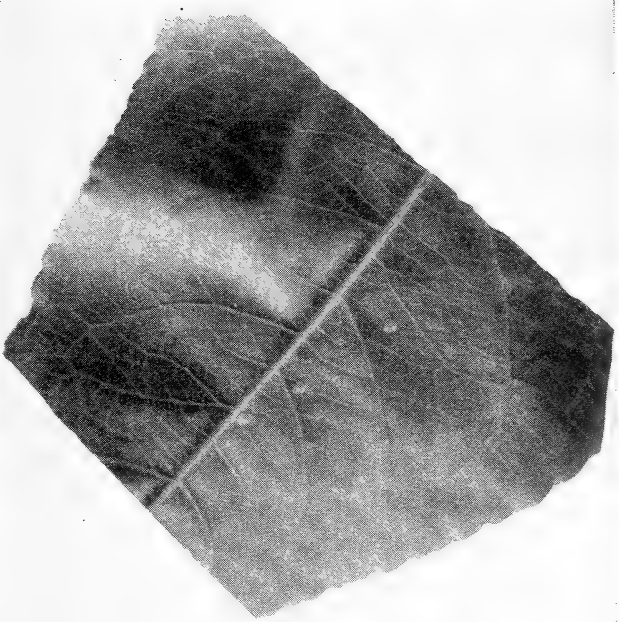


Fig. 3—Eggs on Lower Surface of Peach Leaf

Egg Parasitism

Egg parasitism was not noted prior to 1928 and the only species recovered this season was the cosmopolitan chalcid, *Trichogramma minutum* Riley. *Ascogaster carpocapsae* Viereck, which was present in small numbers can scarcely be considered an egg parasite since its oviposition in the egg of the host does not prevent hatching and development of the parasite takes place in the host larvae.

The occurrence of *Trichogramma* was first brought to our attention on July 3 when an adult was noted on an experimental tree. This led to an examination of peach moth eggs at various points throughout the district during the latter part of July and the parasite was found to be very generally distributed. It should be stated here that the *Trichogramma* adults found in the field at this time were larger and lighter in color than the laboratory bred specimens. Further observations, in conjunction with laboratory experiments, have shown that the size and color of this parasite are greatly influenced by the egg serving as host, as well as by conditions of temperature and humidity.

Fig. 4—Injury to Twig of Peach

In making a survey of its distribution quince trees were used on account of the greater concentration of oriental peach moth eggs on this tree than on peach. Parasitized eggs are readily detected by a characteristic blackening about the 4th or 5th day and the percentage of parasitism was based on the number of these blackened eggs as compared with the number of normal eggs, unhatched and hatched. In the vicinity of Port Dalhousie and St. Catharines the parasitism was only one per cent., but at other points it was considerably higher. At Niagara-on-the-Lake 17 per cent of the eggs were parasitized, at Queenston 12 per cent., at St. Davids 17 per cent., at Stamford 15 per cent. and at Fonthill 25 per cent. This parasitism is undoubtedly higher than that on peach because the greater concentration of eggs on quince increases the chance for *Trichogramma* to find eggs to parasitize. The small number of quince trees in the various localities and the variety of conditions under which they were

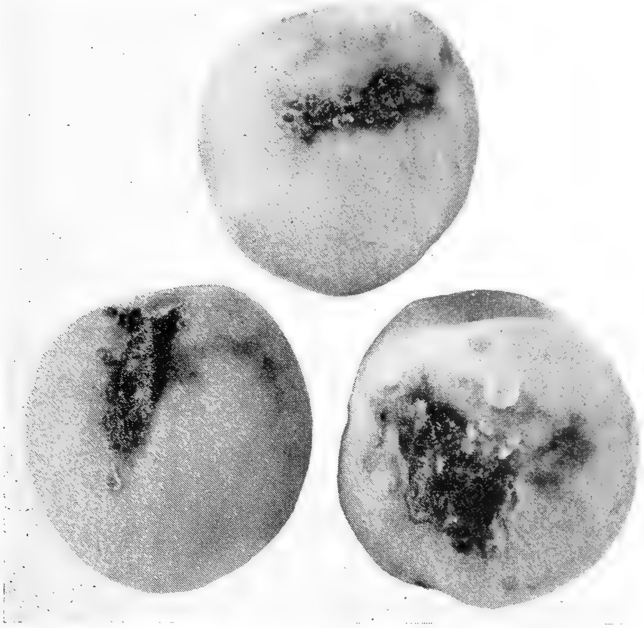


Fig. 5—Peach Moth—Infested Fruit Showing Gum Exudation

growing, together with this greater concentration of eggs on quince suggests that the above counts should not be taken as indicative of the control effected in peach, but only as revealing the presence of *Trichogramma* in the locality.

Parasitism of Larvae and Pupae

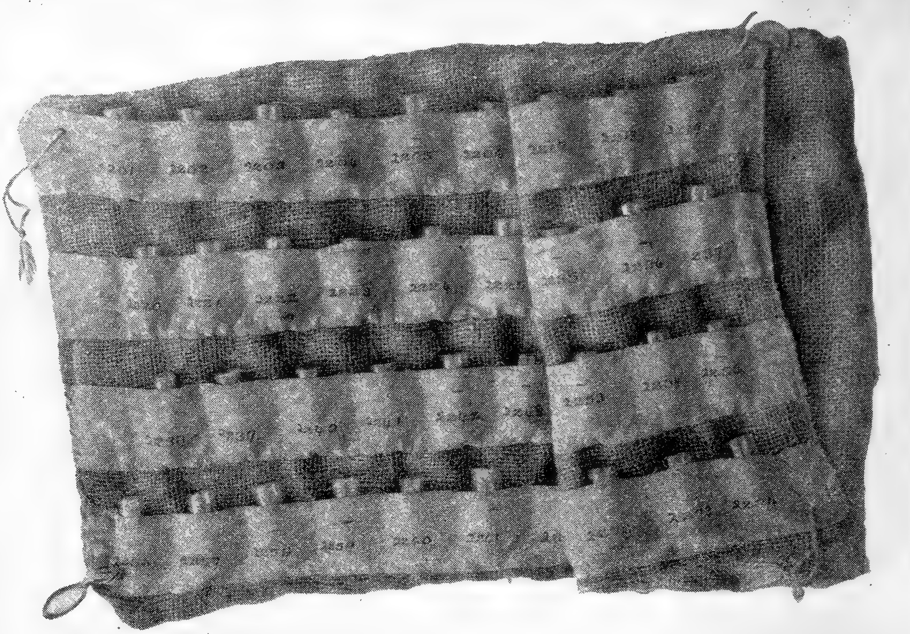
It was not until this season (1928) when periodic collections of larvae were made from infested twigs and fruit, that a special study was made of the parasitism of larvae and pupae. The collections were kept separate so that any differences in parasitism of material from the two sources might be determined. Owing to the shift of the infestation from twigs to fruit, as the fruit develops, twig collections were discontinued at the end of July because of the scarcity of material, but collections of fruit were made throughout the season.

The collections were not made at regular intervals and in the following tables showing the parasites reared from this material the results are grouped in bimonthly periods for convenience of comparison.

Table 1.—Parasites reared from infested peach twigs collected at St. Davids, Ontario.

Period	No. of parasites.	Percentage parasitism.	Species recovered.
June 1-15	0	0	
June 16-30	1	3	*Dioctes obliteratus* (Cress.)
July 1-15	0	0	
*July 16-31	95	15	*Glypta rufiscutellaris* Cress. *Macrocentrus delicatus* Cress. *Cremastus minor* Cush. *Tachinid* sp.

*Collection made in an orchard of small trees near a local canning factory; the parasitism was probably much higher than the average for the district.



F g. 6—Vial-band

Table 2.—Parasites reared from infested peach fruits collected at St. Davids, Ontario.

Period	No. of parasites.	Percentage parasitism.	Species recovered.
June 16-30	2	1	*Triaspis* sp. *Epiurus* sp.
July 1-15	12	3	*Glypta rufiscutellaris* Cress. *Dioctes obliteratus* (Cress.) *Cremastus minor* Cush. *Triaspis* sp.
July 16-31	7	4	*Glypta rufiscutellaris* Cress. *Dioctes obliteratus* (Cress.) *Itoplectis* sp.
Aug. 1-15	11	2	*Meteorus* sp. *Glypta rufiscutellaris* Cress. *Dioctes obliteratus* (Cress.) *Itoplectis* sp. *Microbracon mellitor* (Say)
*Aug. 16-31	4	1	*Tromera* *Glypta rufiscutellaris* Cress. *Itoplectis* sp.
*Sept. 1-15	0	0	....

Of the 9 species of parasites recovered *Glypta rufiscutellaris* Cress., which has been an important factor in the control of the pest in northern New Jersey, was the most common. Unfortunately, *Macrocentrus ancy-*

*Data on this collection not yet complete; many larvae hibernating.

livora Rohwer, which is the major parasite in southern New Jersey, has not yet been recovered in Ontario.

The following table gives a summary of the parasites found attacking *L. molesta* Busck.

Stage of host	Parasite	1926-27	1928
Egg	*Trichogramma minutum* Riley		*
Larva	*Ascogaster carpocapsae* Vier	*	*
	Glypta rufiscutellaris Cress.	*	*
	Glypta varipes Cress.	*	
	Dioctes obliteratus Cress.	*	*
	Cremastus minor Cush.	*	*
	Aneoplex betulaecola Ashm.	*	
	Ephialtes aequalis (Prov.)	*	
	Eubadizon pleuralis (Cress.)	*	
	Microbracon mellitor Say.	*	
	Epiurus sp.		*
	Triaspis sp.		*
	Meteorus sp.		*
	Tromera sp.		*
Pupa	*Itoplectis conquisitor* Say.		*

Experiments in Biological Control With *Trichogramma minutum* Riley

Experiments in biological control with *T. minutum* were carried on in a 75-acre (16 year old) Elberta peach orchard at St. Davids, Ontario, an orchard which has been the centre of heaviest infestation in the district for some years. A check plot was selected in a smaller orchard about one-quarter mile to the east. The parasites used in the experiments were produced at the Dominion Entomological Laboratory, Chatham, Ontario.

As a result of various trial shipments of parasite material, the following method was adopted as the most satisfactory way of handling the material from the time it left the laboratory until it was released in the field: Three-inch paper discs bearing parasitized eggs were packed at the laboratory in cylindrical ice-cream cartons and mailed to destination. On arrival the discs were removed and placed individually in Petri dishes where they remained until the flies were ready for liberation. The development of the *Trichogramma* was hastened or retarded within certain limits by placing the material in a warm room, or in a cool cellar.

As very little information was available regarding the behaviour of *Trichogramma* in the field, the work in 1928 was largely in the nature of experiments planned with a view to determining the reaction of the parasite to liberation under different conditions, and also for the purpose of determining how many individuals to liberate, how often to liberate and when to liberate.

The flies were released in the experimental blocks by three slightly different methods. By the first, the Petri dishes were opened and the flies tapped out on large limbs near foliage. By the second, the dishes were opened and the flies not tapped out, but allowed to escape at will. After all the emerged adults had left the dish it was closed and left until the following day when the later emerging flies were released. By the third, the dishes were opened near foliage and the emerged flies allowed to escape. The paper discs bearing the host eggs were then either stuck to peach gum on the trees, or fixed on small twigs.

*Indicates parasites recovered.

The most satisfactory method appears to be the third, or, on cool days, a combination of the first and third. That is, the release of all emerged adults, the paper discs to be then left on the tree so that the few remaining flies may emerge at will. On dull or cool days, when the flies do not leave the dishes readily, they may be liberated more rapidly by the tapping method, the paper discs, however, should be left on the trees.

Behaviour of Trichogramma on Liberation

When tapped out on the limbs the flies almost invariably scatter and run rapidly upwards. They proceed usually in short spurts broken with intervening spells of preening. In bright sunlight the flies take to wing and scatter readily. On cloudy days they show great activity while the sun is bright, but decrease their activity markedly in the shadow of a passing cloud. On windy days the flies cling tightly to the supporting surface and during lulls work their way cautiously to more sheltered positions. If, on windy days, the sun is bright they will take to flight between breezes, but seldom take off while the wind is blowing.

When the containing dishes are simply opened and the flies allowed to escape at will, the actions are quite similar to those of flies tapped out. That is, in bright sunlight, activity and dispersal is greater than in shade or in less intense light. In strong winds the flies leave slowly.

The time of day appeared to have little influence on the behaviour of the flies except that the intensity of light is different at different times of the day and thus influences slightly the activity at these times. All the liberations were made between the temperatures of 66 and 88 degrees F. and within this range light was a more important factor than temperature in determining the activity of the flies. Differences in temperature produced no marked differences in activity.

Oviposition

Peach moth eggs exposed to *Trichogramma* were attacked within a few minutes after exposure and, although the majority of the eggs appeared to be encountered by chance, one instance was noted where a fly reversed its position and made straight for an egg one-half inch away. When it reached the egg it stopped, worked back and forth over it several times and then commenced to oviposit.

Several instances were noted of flies one-eighth inch away going directly to eggs, but in other cases flies within that distance paid no attention to them whatever. In only one or two instances were flies seen to pass over an egg without stopping to examine it. Usually they stopped and commenced to oviposit. In cases where little attention was paid to eggs the flies may have been males. Three to five minutes were required for oviposition, and as many as three flies have been seen working on one egg at the same time.

Generations Per Season

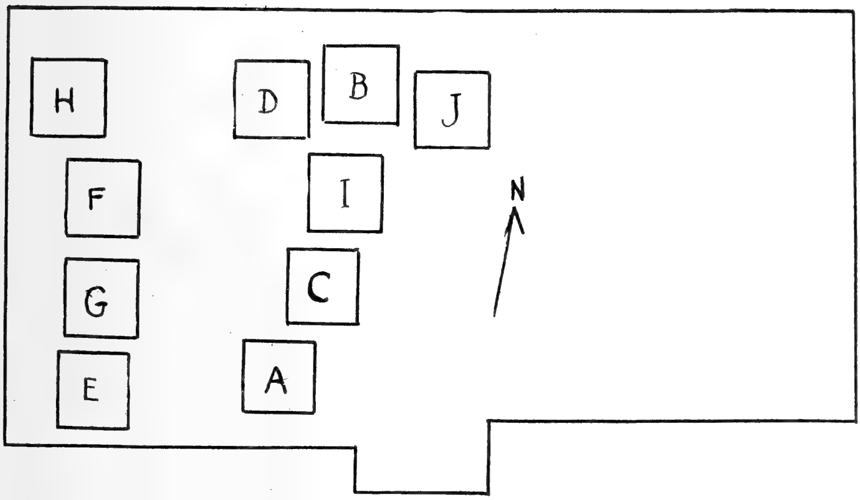
The length of time required for the life cycle of *Trichogramma* varied somewhat with the advance of the season and also with the temperatures at the different periods. From July to October (three months), five generations of *Trichogramma* occurred in the field. Although daily observations on development ceased about the first of October one adult was seen in the field as late as October 24.

Development during the season was as follows:

Generation	Period (approx.)	Days until characteristic blackening	Days for complete cycle
First	Early July	4- 6	11-13
Second	Late July	4- 6	11-13
Third	Early Aug.	6- 7	14-15
Fourth	Late Aug.	4- 6	13-17
Fifth	September	9-10	21-33

EXPERIMENTAL BLOCKS

In order to carry out the several experiments, ten one-acre blocks of approximately 100 trees each were selected in the large 75-acre Elberta peach orchard previously referred to. A check plot was selected in a small orchard about one-quarter of a mile to the east. The following diagram gives an idea of the location of the blocks in this orchard. These were confined to the western section of the orchard because of the more even stand of trees there. All blocks were separated from each other by one or two rows of trees.



Showing location of experimental blocks in the large 75-acre Elberta peach orchard at St. Davids, Ontario. Each block covers one acre of land and contains approximately 100 trees.

The liberations of *Trichogramma* in these blocks were planned with the object of determining their effect on *L. molesta* eggs present in the field from the beginning until the end of the season, and also for the purpose of determining the relative merits of single and repeated liberations, of various sized liberations and of different times of liberation. The loss of a quantity of *Trichogramma* breeding stock early in the season due to a faulty thermostat on one of the rearing incubators prevented early liberations during the peak of the first generation peach moth egg lay. It was possible, however, to make liberations from June 25 until September 13. These liberations indicate that best results were obtained from those made where the host eggs were reaching a peak. The results obtained from liberations made when the host egg lay was on the decline were not as favourable.

The results show a greater parasitism with the larger liberations and with greater numbers of liberations. The degree of parasitism, however, was not commensurate with the number of flies released, and was much less than twice as great when twice the number of flies were released. The natural occurrence of *Trichogramma* is a factor influencing these results and, at the same time, one difficult to separate. It was not possible to make liberations of any considerable size and possibly greater differences in the results should not have been expected. In some cases 150 flies constituted a liberation and the highest number of flies received by any one block during the entire season was 47,000 and not more than 13,000 flies were ever released at a single tree at one liberation. Although the liberations may be considered as small, individual counts of *L. molesta* eggs in the experimental blocks showed as many as 40 per cent. to be parasitized.

Dispersal was towards the northeast or with the prevailing southwesterly winds. No attempt was made to determine the extent of dispersal from the liberation point owing to the natural occurrence of *Trichogramma* which was found to be present in the late season in all parts of the orchard.

Check Block

The natural occurrence of *Trichogramma* was equally apparent in the check block, but it did not become evident there until October. It may be recalled that the natural occurrence of *Trichogramma* was noticed in the large orchard as early as July 3rd. The reason for its delayed appearance in the check plot is not known, unless its occurrence in the spring is extremely local in which case it might be expected to spread from orchard to orchard during the season and become more midely distributed.

Conclusions

Although the results of the experiments were not as conclusive in showing the value of different methods of liberation as was expected, due in part possibly to the natural occurrence of *Trichogramma* and to the smallness of the liberations, much information was secured on the biology of *Trichogramma* and on its prevalence in the district.

Data secured from collections of larvae from infested peach twigs and fruits are significant in revealing the small percentage of parasitism occurring in this stage and also in revealing the absence of *Macrocentrus ancylivora* Rohwer which is the most important parasite in southern New Jersey.

SOME REMARKS ON THE PRESENT STATUS OF INSECTICIDAL AND BIOLOGICAL CONTROL INVESTIGATIONS FOR THE ORIENTAL PEACH MOTH, *Laspeyresia molesta* Busck

Alvah Peterson, Ohio State University, Columbus, Ohio

Introduction

The oriental peach moth, *Laspeyresia molesta* Busck, is found in most peach producing areas in the eastern half of North America. In many districts, particularly in newly infested northern areas, it is a serious problem in peach and quince production and under certain conditions attacks apples and pears. The development of a satisfactory control for this pest is challenging the ingenuity of entomologists and fruit growers to a greater degree and extent probably than any other fruit pest thus far known.

Since 1918 the writer has been observing and conducting experiments for the control of the oriental peach moth. Even as early as 1920 the difficulties of the problem were realized. The appreciation of these difficulties has increased considerably as the years have gone by for innumerable experiments of a greatly diversified nature have failed to overcome the ravags of this insect. In spite of all the failures to date the writer believes that possibilities for the discovery of a satisfactory control with insecticides (including attractants and repellents) or cultural practices still exist. How many of these possibilities will prove to be improbabilities remains to be seen.

The first part of the paper will discuss some of the more important possibilities along insecticide lines; the second part of the paper will discuss the effective work of some environmental factors and natural enemies.

INSECTICIDES

It is believed that complete and satisfactory control by means of an ovicide alone may never take place. The short hatching period of the eggs, their location on the tree, and their continuous presence in the orchard from spring until fall are the chief reasons that make an ovicide, as a complete panacea, highly improbable. An ovicide may assist, however, in control if one is found which can be incorporated into, or combined with, the regular spraying or dusting program.

The field of larvicides still offers possibilities even though an insecticide which acts strictly as a stomach poison may never prove to be very effective against the larva because of its peculiar feeding habit. Other types of larvicides may be discovered. One of these the writer investigated several years ago. In some experiments with newly hatched larvae it was observed that many larvae died when forced to crawl over leaf surfaces that had been coated with various chemicals, particularly with nicotine, beta napthol, lime, chalk, etc. Where nicotine or beta napthol were used the larvae probably died from breathing toxic gases or from coming in contact with the poisons, while in the experiments with lime, chalk and other powders dusted and sprayed onto the foliage, the larvae probably died from starvation and desiccation. The small particles of powder entangled many of the larvae to such an extent that they were unable to make progress and reach the point of the plant (twig or fruit) where they could secure their first meal. This method of killing larvae which chew their food is somewhat out of the ordinary yet it has possibilities, particularly with newly hatched larvae as small as the oriental peach moth or the codling moth. One of the difficulties which will have to be met in using the larvicide of this nature will be the problem of maintaining a coat on smooth foliage and fruit for the entire season, particularly during heavy rains and high winds.

It is believed that a satisfactory dormant spray would assist greatly in the control of the oriental peach moth. In the dormant season all larvae are in cocoons and many of these are located on the trunks and larger branches of fruit trees. This is the only season of the year when all the individuals of the species are in one stage of development.

Even if a satisfactory dormant spray is found which will kill all the larvae in the cocoons located on the trees the problem will not be solved by thorough spraying. Many larvae are located on or in trash on the ground where a spray cannot reach them. Therefore early cultivation will be needed and this is not possible or practical in many peach orchards. It is also probable that a dormant spray control will necessitate community spraying of all fruit trees; otherwise the moths may migrate from unsprayed to sprayed orchards.

A considerable number of diversified experiments have been conducted with the adults. It has been learned that artificial electric light traps for capturing moths in peach orchards are useless and impractical. Many adults are attracted to baits, particularly to fermenting products which possess sugars. The number and the percentage captured, which seldom exceeds ten per cent., is not sufficient to materially reduce the infestation. To bring about satisfactory control it is believed that 90 per cent. or more of the gravid females present in the orchard at any and all times should be captured.

Negative chemotropic responses offer some promise for control. The entire subject of repellents for insects is a field of investigation which has been insufficiently studied; consequently it will require considerable time to develop a satisfactory technic for testing various products. Thus far we have learned that certain chemicals placed on foliage under laboratory conditions will prevent oviposition. These need to be given field tests. In case an effective product is found which will prevent oviposition we still face the problem of maintaining a coating or zone of repellency about the tree for the entire season. The question also arises as to what will occur if every tree in the orchard and nearby orchards are protected by repellents. Will the repellent fail to repel under these circumstances?

This suggests the theoretical possibility of using a combined program of repellents and attractments in the same orchard as proposed by Mr. Lipp. If some of the trees possess attractments and others possess repellents it might be possible to concentrate the infestation on a few trees which would make it easier to handle the infestation with other insecticides.

Other interesting points which have an important bearing on artificial control studies might be considered. Instead of discussing these the subject of natural or biological factors which influence the development and the abundance of the pest will be considered.

Environment

Environmental factors and natural enemies have a marked influence on the abundance of the insect. One important environmental factor is the question of food supply. Early in the summer the food supply in a peach orchard is usually abundant, but late in the season after the twigs start to harden the food supply may vary considerably. This variation may be due to the fruit present in or near the orchard. If there are late varieties of peaches in the orchard or other fruits (quince, apples and pears) near the orchard, then the food supply is usually sufficient to produce a large number of wintering larvae which in turn will give rise to a moderate or large spring brood emergence of moths. When there are no peaches or other fruit present in or near the orchard and all the twigs have hardened then the possibility of producing a large wintering population, and in turn a large spring brood emergence, does not exist. Conditions about Fort Valley, Georgia, exemplify this situation. Scarcity of food late in the season also may occur in sections where no fruit is present due to freezing or frosts. The absence of fruit in one year usually reduces the infestation for the following season.

Wet weather indirectly affects the development of larvae in growing peach twigs. Peach trees take up moisture rapidly, particularly after a dry spell, and each larval injured twig usually shows an excessive flow of sap which congregates near the injured portion of the twig in a jelly like mass. The accumulation of sap forces many larvae to abandon the twigs temporarily or seek uninjured twigs. Some of these larvae are lost. Larvae unable to escape from the flow of sap appear to be caught in it and die.

Their appearance after death indicates that they were drowned.

Temperature has a decided influence on the rate of development and the activity of the several stages of the insect. In most respects the several stages of the oriental peach moth respond to the same range of effective day degrees, 50°-86° F., as the codling moth. The rate of development in the oriental peach moth is more rapid than in the codling moth. Oriental peach moths deposit few or no eggs when the temperature is below 60° F. Maximum egg production occurs between 70° to 90° F. Very few eggs are deposited in the presence of high winds or heavy rains.

Natural Enemies

Fungi and insect parasites are the chief natural enemies and they play an important part in the biological control of the pest. Several species of fungi attack and kill the wintering larvae in the cocoons. In some orchards the percentage of mortality of wintering larvae on the trunks of fruit trees runs as high as 50 to 75 per cent. This is especially true of larvae on quince trees where wintering cocoons are likely to occur in bunches under the large loose flakes of bark. Larvae in cocoons located near the ground are more apt to be diseased than those situated well up on the tree.

Some forty or more species of parasites have been reared from the several stages, particularly the larval stage, of the oriental peach moth. Many of them are parasites of closely related hosts; namely, the codling moth, several leaf rollers, and similar species. The discussion of the parasites will be confined to the three most important species: *Trichogramma minutum* Riley, an egg parasite; *Macrocentrus ancylivora* Roh, and *Glypta rufiscutellaris* Cress, larval parasites.

The egg parasite is *Trichogramma minutum* Riley, a common parasite of the eggs of many insects. Under orchard conditions this parasite in some districts is common in the eggs of the oriental peach moth and the codling moth late in the season. It is likely to be unevenly distributed in a given orchard. Probably the presence of other hosts on the vegetation in the orchard may have some bearing on this.

The insect requires 8 to 50 or more days (depending upon temperature) to complete a life cycle (egg to adult). During most of the summer a life cycle is completed in 9 to 15 days while early in the season it requires 30 days or longer and late in the fall when temperatures are low 30 to 50 days or more. In the vicinity of Philadelphia there are 12 to 14 generations per season. The writer has succeeded in wintering a few individuals on the eggs of the oriental peach moth; however, it is probable that very few or no individuals pass the winter in oriental peach moth or codling moth eggs in the average orchard, because few or no eggs of these species are present in the orchards when wintering individuals are produced. This means eggs of other insects must serve as wintering quarters. In the vicinity of Philadelphia temperatures are too high during most of September and early in October to prevent emergence of the parasite. When the temperature averages exceed 48° to 50° F. for 30 to 50 days or longer parasites will continue to emerge. Eggs parasitized before October 15th about Philadelphia are likely to produce adults during the current season. Emergence out of doors may occur as late as the middle of December.

One female will parasitize 10 to 50 eggs. Most of the parasitism under laboratory conditions takes place the first or second day after emergence. Females live in captivity 1 to 15 days depending upon temperature and humidity.

All of the above facts have some bearing on the possibility of using this parasite for biological control. The writer thinks that to obtain any measure of biological control with this parasite it will be necessary to make

frequent and large liberations of reared material, particularly early in the season. The liberations will probably have to be evenly distributed throughout the orchard, possibly in every tree.

From a number of preliminary tests where several hundred fertilized female parasites were liberated in eight year old peach orchards during June and July, when little or no natural infestation occurred, it was learned that adults liberated in trees adjacent to other trees where eggs were located seldom found and parasitized the eggs, while adults liberated in the same tree where eggs were placed usually parasitized a goodly portion of the eggs. All liberations were made under favorable weather conditions so far as we know.

Trichogramma minutum offers possibilities for biological control, and yet there is a great deal to be learned before an investigator will be in position to state that this egg parasite will control the oriental peach moth in an orchard.

The most important larval parasite in southern New Jersey and nearby states is *Macrocentrus ancylivora* Roh. Care should be taken not to confuse this species with *Macrocentrus delicatus,* a codling moth parasite frequently found in oriental peach moth larvae. So far as known *Macrocentrus ancylivora* Roh is a native parasite. Mr. Haeussler has shown that *Macrocentrus ancylivora* for three years parasitized 45 to 72 per cent. of all larvae infesting twigs in several young orchards near Moorestown, New Jersey. Some collections of host larvae have shown 90 to 100 per cent. parasitism. *Macrocentrus* constitutes about 90 per cent. of all the larval parasites in the area mentioned. This parasite has 3 or 4 generations per season.

It would seem that parasitism by *Macrocentrus ancylivora* is the most important factor which has brought about such a decided reduction in the infestation of oriental peach moths in the twigs and fruit during the latter half of the summer about Moorestown, N. J. (near Philadelphia) for the past three years, particularly in 1927.

To date secondary parasites, which may attack *Macrocentrus,* are almost unknown. If secondary parasites do establish themselves in large numbers infestation in the fruit will probably increase.

Macrocentrus ancylivora is only effective where it has access to larvae located in growing twigs. It does not or cannot parasitize many larvae located in fruit. This is where the parasite fails. Late broods of larvae which develop exclusively in fruit and produce wintering individuals are likely to be free or nearly free of parasitism by *Macrocentrus.*

Even though wintering oriental peach moth larvae seem to harbor comparatively few *Macrocentrus* parasites, we know that the first brood larvae of the oriental peach moth may be highly parasitized, 35-75 per cent., the following season. This indicates that *Macrocentrus* winters in some common host or hosts other than the larvae of the oriental peach moth. It has been shown that the strawberry leaf roller, *Ancylis comptana* Froehl, is a satisfactory host. Perhaps several other species of leaf rollers and hosts with habits similar to leaf rollers or the oriental peach moths may be found which will serve as wintering hosts for the parasite.

In the vicinity of Philadelphia, Pa., the early and high parasitism among the larvae in the twigs for the past several years has reduced the infestation of oriental peach moths late in the summer to such a point that very few moths are present in the orchards about the time larvae go directly into the fruit; consequently a much smaller number of host eggs are present in the orchard. Also at this time of the year *Trichogramma minutum* is usually abundant and many of the eggs become parasitized.

Macrocentrus ancylivora is more abundant in the vicinity of Philadelphia and south of this point than it is in northern localities. This has caused some entomologists to conclude that it is a southern species and temperature limits its northern distribution. This may be true; however, *Macrocentrus ancylivora* is reported by Garman to be abundant in Connecticut, and so temperature may not be the factor which limits the distribution of this species. Secondary parasites, the absence of other hosts, particularly wintering hosts, or other factors, may play an important part in the distribution of the parasite.

Glypta rufiscutellaris Crass is an effective parasite in some peach orchards in northern New Jersey and Pennsylvania. Unfortunately we do not know as much about this species as we do about *Macrocentrus ancylivora.* Mrs. Stearns has shown that this species takes the place of Macrocentrus in some of the orchards in Northern New Jersey. For this reason it has been assumed that it is a more northern species than *Macrocentrus ancylivora.* Such may be the case; however, its abundance in a given orchard may be due to the presence of important hosts other than the oriental peach moth. Its host relationship may prove to be a more important factor in its distribution than temperature. *Glypta rufiscutellaris* is a valuable parasite and should be studied extensively and intensively. If it proves to be a species better adapted to northern conditions than *Macrocentrus ancylivora,* then it might prove to be a valuable species for Ontario.

In concluding the discussion on biological control the most outstanding fact which has greatly impressed the writer is the long and varied list of native parasites which have been reared from the several stages, particularly the larval stage, of the oriental peach moth. This gives a most hopeful outlook. It opens up decided possibilities of finding new and effective parasites as the oriental peach moth spreads into new areas in a given country or into new countries. Undoubtedly many native parasites are apt to attack and adapt themselves to some stage in the life cycle of the host. Even though we do not know the native home of the oriental peach moth this should not prevent us from transferring useful native parasites from one territory to another in a given country or internationally.

Furthermore it is possible that parasites on insects which have habits similar to the oriental peach moth in countries where the oriental peach moth does not occur might adapt themselves to the oriental peach moth. These should be studied, introduced, and carefully observed under controlled conditions.

Two attempts have been made to transfer *Macrocentrus ancylivora* from New Jersey to other states. Last season over ten thousand field collected first brood larvae, which proved to be highly parasitized, were shipped from New Jersey to Fredonia, New York. The results of this experiment should be of interest to Canadians. Mr. Daniels of the New York Agricultural Experiment Station supervised this work.

In concluding this paper the writer might add that he is inclined to believe that peach growers in most parts of the world will eventually rely upon biological control and cultural practices rather than upon insecticides and chemotropic responses for the destruction or control of *Laspeyresia molesta* Busck.

DISCUSSION

PROF. CAESAR.—About how many *Macrocentrus* parasites were introduced into New York State from New Jersey this year?

MR. DANIELS.—Less than 2,000.

PROF. CAESAR.—How did you rear these?

MR. DANIELS.—We put green apples into a container and then put the imported peach twigs containing the larvae upon them. The larvae migrated from the twigs into the apples and completed their growth in them. We also kept some of the twigs in New Jersey until the larvae reached the pupal stage and then shipped them. The latter seemed the better way.

PROF. CAESAR.—How long did it take to collect the twigs?

MR. DANIELS.—Four boys collected 10,000 twigs in seven days.

PROF. CAESAR.—Were you able to recover the parasites this fall?

MR. DANIELS.—Yes, quite easily in the area where we freed them but not elsewhere.

MR. ROSS.—Will Trichogramma attack the eggs of the European Red Mite?

DR. PETERSON.—I tried this on a small scale but had no success. Off hand I would say that it will parasitize almost any egg with a soft shell.

PROF. CAESAR.—Have you seen any indications that low temperature in winter will kill hibernating larvae of the Oriental Peach Moth?

DR. PETERSON.—I am inclined to believe these insects will withstand any temperature that the peach tree itself can withstand.

NOTES ON THE RED SPIDER ON BUSH FRUITS, *T. telarius* L.

W. G. GARLICK, DOMINION ENTOMOLOGICAL LABORATORY, VINELAND STATION, ONT.

INTRODUCTION

This paper is chiefly concerned with the life-history of the common red spider and represents experiments carried on during a part of 1927 and 1928 at the Vineland Station laboratory. Hitherto the published accounts of the life-history of this mite have dealt with climatic conditions very different from those existing in this locality. For this reason, together with the fact that the red spider has caused serious injury to local raspberries and black currants, the life cycle was followed fairly closely.

METHOD OF STUDY

The mites were reared in the insectary on potted raspberry and black currant plants covered with lantern chimneys without tops. Where necessary mites were confined to leaf or plant by a smear of tanglefoot on petiole and lantern chimney rim respectively. Some of the plants were kept in the shade whilst others were exposed to the full rays of the sun. The temperatures were recorded by a thermograph with the shaded bulb not more than ten feet away from any of the plants. A hygrograph (a separate unit) was freely exposed just above the thermograph. All average reading for any period were obtained by averaging hourly readings from the charts. Individual females were examined for egg counts once a day and immature forms were examined usually four times a day.

LIFE HISTORY

EGG

The egg is spherical, smooth, and when first laid clear, resembling a minute drop of a fluid. An average diameter of .128 mm. was obtained from the measurement of 110 eggs taken from three sources. The ex-

tremes were .113 to .141 mm. As a colour exception to the above the first two or three eggs laid by overwintering females in the spring were of a dirty brown colour.

The incubation period of 100 eggs throughout the season varied from 3.2 days at an average temperature of 81.7° F. to 32 days at an average temperature of 44.5° F.

Most of the eggs under observation hatched but a few did not. Some of these turned brown as if attacked by a fungus, others remained just as when laid. In one case two eggs appeared as fresh after 60 days had elapsed as when first laid.

As hatching time approaches the egg becomes opaque, of a dull pearly lustre, and bright red eye-spots can just be seen with a hand lens.

Larva

On emerging from the egg the tiny larva is almost circular in outline, of no distinct colour and it is six-legged. With feeding it assumes a greenish colour.

The larvae rarely left the leaflet on which the eggs were laid but in a few cases they managed to crawl to other leaflets or leaves on the plant. The larval period, from observations on 92 larvae, varied from 28 hours at an average temperature of 77.4° F. to 10 days at an average temperature of 56.9° F. The larval period consists of two stages, an active stage followed by a quiescent stage.

The active stage of 92 larvae varied from 8 hours at an average temperature of 85.7° F. to 7 days at an average temperature of 55.1° F.

The quiescent stage is characterized by the larva attaching itself to leaf or web and remaining inert until molting takes place. Throughout the quiescent stage the larva assumes a dead appearance and looks as if the skin to be cast later had already separated. In experiments with 92 larvae the stage varied from 8 hours at an average temperature of 82.3° F. to 5 days at an average temperature of 53.9° F. The quiescent stage may be longer or shorter than the active stage, the difference where marked, being attributable to temperature. An average of 92 larvae gave active stage 1.7 days, quiescent stage 1.4 days. These figures are not intended to show the average length of each stage but the ratio of the one to the other. At the end of the quiescent stage the skin is ruptured transversely at the middle and the protonymph crawls out.

Protonymph

The protonymph has eight legs and is like a small edition of the adult. The protonymph period varied from 1 day at an average temperature of 81.6° F. (average of 4 individuals of equal duration) to just over 7 days at an average temperature of 52.1° F. The protonymphal period, like the larval, is divided into an active and a quiescent stage.

In the insectary the active stage of 91 protonymphs varied from 8 hours at an average temperature of 84.0° F. (average of 5 individuals of equal duration) to 5 days at an average temperature of 55.5° F.

The quiescent stage of 91 individuals varied from 8 hours at an average temperature of 75.9° F. to 6.2 days at an average temperature of 47.7° F. As stated above for the larva the protonymphal quiescent stage may be longer or shorter than the active stage and for the same reason. The ratio of one to the other as obtained from 91 protonymphs being, active stage 1.43 days, quiescent stage 1.39 days.

Deutonymph

In the deutonymph, which is the last of the immature stages, the variable black markings so characteristic of the adults are pronounced and the size of the individual may be very nearly equal to that of the adult. The deutonymphal period varied from just over 1 day at an average temperature of 85.2° F. (average of 4 individuals of equal duration) to 12 days at an average temperature of 49.6° F. The deutonymphal period also consists of an active stage and a quiescent stage.

The active stage of 91 deutonymphs varied from 8 hours at an average temperature of 91.3° F. (average from 3 individuals of equal duration) to 12 days at an average temperature of 50.1° F.

The quiescent stage of 91 deutonymphs varied from 16 hours at an average temperature of 80.6° F. (average of 2 individuals of equal duration) to just over 8 days at an average temperature of 51.0° F. The quiescent stage may be shorter or longer than the active stage with the larva and protonymph. The ratio for 91 deutonymphs being active stage 1.6 days, quiescent stage 1.8 days.

Immature Period

The shortest immature period in the insectary was just over 4 days at an average temperature of 79.7° F and the longest 29 days at an average temperature of 53.2° F.

No variation in the duration of the immature period, or of the six stages comprising that period, could be directly attributed to sex, host plant, or change of host plant of the parent. For this reason all figures presented included data on individuals of both sexes reared on black currant or raspberry. Both sexes pass through the same immature stages and in the insectary both required, on an average, about the same length of time to reach maturity. The sexes of the immature forms could not be told apart, at least with a hand lens, but the adult males were able to distinguish between male and female quiescent deutonymphs. The changes of host of the parent included transference from greenhouse cucumber to raspberry, from peach to raspberry, from raspberry to currant and from currant to raspberry.

It will be noted that the ratio of active to quiescent period in the larva, protonymph and deutonymph goes through a reversal. The active period is the longer in the larval stage, there is practically no difference between active and quiescent in the protonymph, and in the deutonymph the active period is the shorter. The ratio of the active to quiescent period for the entire immature period is nearly 1 to 1. The figures are given in the table below. The important point is that the quiescent stage is more resistant to spray materials and probably to predaceous enemies also and that very nearly one-half of the immature period is passed in this stage.

Table showing ratio of active to quiescent period (expressed in days):

Stage	Active	Quiescent
Larva	1.72	1.43
Protonymph	1.43	1.39
Deutonymph	1.61	1.84
Total	4.76	4.66

The close correlation between the temperature and the time taken to develop from egg to adult is well shown in the table below. The figures given are for 79 individuals during the season of 1928. The period covered is from the time the egg was laid until the deutonymph molted to the adult.

Table showing relation of temperature to development:

Number of Mites	Average Temperature (degrees F.)	Egg to Adult Period (in days)
9	56	35.9
1	59	28.5
3	60	24.6
1	61	26.0
4	65	17.8
3	66	16.5
4	68	15.4
3	69	14.9
2	70	13.9
15	71	12.8
5	72	11.7
7	73	10.9
19	74	10.7
1	75	10.8
2	77	9.3

ADULT

The adult male differs from the female chiefly in the shape of the abdomen which tapers caudad to an obtuse point. The legs appear to be longer and are often of a faintly reddish tinge terminally. The body colour is much the same as that of the female except that usually the colour is not so intense and the black markings seldom cover so large an area as they commonly do in the female. In general the male is far more active than the female and when placed solitary on a potted raspberry plant soon investigates every leaflet on the plant. Males arise from both mated and virgin females and those arising from the latter are capable of fertilizing females. It is usual to find the male closely attentive to a female deutonymph, jealously guarding his charge against other intruding males. In such cases mating usually takes place shortly after the molting of the female deutonymph. Males were seen to mate with more than one female and sometimes apparently with the same female more than once. The longevity of mated males was not ascertained. After mating they did not die immediately but were observed to be active for several days. In the case of unmated males one lived 36 days, two 53 days, and one for 72 days. None of these were found dead, they disappeared at the end of the periods given above.

So far as could be gathered from one winter's observations and not too many individuals the males do not survive the winter. No forms comparable to the overwintering females were seen and of the mixture of males and females wintered out-of-doors in moss only females were recovered in the spring. Furthermore, no males were observed accompanying the solitary females found early in the spring on young raspberry shoots in the field.

The female is larger than the male and is ovate in outline. It varies greatly in colour—the dorsum being black, green, reddish-orange or orange and, with the exception of the black, various intensities of these colours. The black usually accompanies the other colours and may mask them. The black, whilst commonly consisting of a spot on each side of the dorsum varies greatly and may include practically all of the dorsum. Occasionally there is a dark stripe down the middle of the dorsum which may or may not be accompanied by the lateral spots. On the insectary

plants (black currant and raspberry) green with a varying amount of black was the prevailing colour during the summer. This was also true of the mites found on raspberries in the field where not numerous. Where very numerous they were commonly a pinkish shade and the black markings seemed to be less noticeable. The green colour is probably due to chlorphyll and where there is a heavy infestation and the chlorophyll largely removed from the leaves by the mites their bodies lose the charactristic green colour. The black markings under such circumstances also tend to be of less frequent occurrence. These black markings seem to be associated with feeding, becoming more noticeable where feeding is continuous. Thus on an overstocked plant or leaf many individuals would reach maturity on a minimum of food and the black markings in consequence would not be so pronounced.

For its size the female must remove from the host a large quantity of plant juice. To begin with the eggs are comparatively large and must require much food in the making. Three and a third diameters of an average egg gives a greater length than the average female and two and a third diameters of an average egg a greater width than the average female. The amount of material in 100 eggs, which is a normal quota for one female, must therefore be several times the volume of the female body. Furthermore, it was often observed that an actively feeding female excreted drops of a fluid. These drops resembled eggs to a remarkable extent and were of about the same size but they were clearer than eggs and nearly always collapsed in less than a minute.

One mating sufficed to fertilize the female for life. Overwintering females mated in the fall.

The preoviposition period varied from just under one day to 6 days for the summer forms. It was about one day for practically the whole of July, 1928.

Usually all the eggs were laid in a small compass but where conditions were not altogether favourable, such as a dense pubescence on the under surface of raspberry leaves, the eggs were scattered over the entire lower surface of the leaflet. Certain individuals laid nearly all of their eggs on webbing, others entirely on the leaf surface. In the insectary the maximum number of eggs laid by an overwintering female was 179, and by a summer female 204. The average number of eggs from 73 females (including overwintering and summer forms) was 90. A single overwintering female (not included in the above figures) laid no eggs at all though it lived and fed for 28 days in the spring. The maximum number of eggs laid by a single female in one day was 12. The average number of eggs per female per day was 3.4.

The egg-laying period varied from 3 to 70 days with an average for 73 females of 26 days.

Females seldom survived the egg-laying period by more than a few days so that for the summer forms the longevity was a day or so more than the egg-laying period. Of 43 summer females the longevity ran from 5 to 55 days with an average of 23 days. The exact age of the winter forms was not discovered, but adults captured on November 3, 1927, lived in many cases into June, 1928, and in one case to July 24, 1928, a period of 264 days.

Overwintering Form

The overwintering female is of a distinct orange or orange-red colour. This form was first seen in the insectary on September 5, 1927, when one matured. Mating was observed but no eggs were laid within the following ten days. These orange forms increased through September and October

but right up to the time the foliage was killed by frost there were still summer forms and eggs on the plants. In many cases the overwintering forms did not seem to feed at all in the fall and no dark markings appeared on the dorsum. Others appeared to feed and took on varying amounts of black markings. They were not observed to wander from the plants and moved around scarcely at all, usually remaining motionless, unless disturbed, on the under side of the leaf. On November 14, 1927, ten of these overwintering females were brought into the greenhouse and kept on a raspberry plant. The plant sent out some new growth but by January 21, 1928, no eggs had been laid by the females which were all alive. On November 2, 1927, winter and summer forms were together put in moss in flower pots which were partly buried in the soil. Only the winter forms survived this treatment and these began to lay eggs in a minimum of two days from the time they were put on raspberry plants in the spring. On November 4 and 5, 1927, four glass tubes containing mites were partly buried in an upright position in the soil after the open ends had been plugged with cotton. The exposed portion was protected with a brown waterproof paper cap. These were examined during the winter. On January 11, 1928, the tube containing 25 overwintering females showed no change since the mites were put in; all appeared healthy. In the tube containing 20 summer females there were three eggs, much webbing and two or three mites which appeared to be alive—that is, they were not shrunken though of course inactive from the cold. The green colour had gone but the mites were not red. In the tube containing males only, not a single live male could be seen. The last tube contained a mixture of the foregoing forms and on January 11 the overwintering females seemed to be alive and one each of the summer females and males appeared to be alive. Unfortunately, no further examinations were possible owing to the removal and loss of the tubes by some disinterested person.

With feeding in the spring the black markings soon appeared and the females turned a brownish red, later changing to dark brown and finally to greenish but always of a darker hue than the summer forms.

Number of Generations

In 1927, six complete generations and the egg stage of a seventh were reared between May 30 and November 30. This is probably too low a figure but a direct line of the mite is not readily manipulated. The minimum time from egg to egg—that is, from the moment an egg is laid till the moment the resulting female has deposited its first egg—was ten days in 1928. For the last week in June, the whole of July and the first half of August of 1928 the egg to egg period was approximately 12 days in the insectary. At the twelve day rate there would be sufficient time for four complete generations in this period. When it is mentioned that eggs were found in the field on May 1, 1928, and as late as November 11, 1927, it can be realized that the seven generations mentioned above is too low a figure for field conditions.

Injury to Raspberry

Unfortunately for the grower an outbreak of red spider on raspberry usually occurs in the Niagara district at a time when most damage can be done, *i.e.*, from ten days to two weeks before picking commences. The current season's crop is thus greatly reduced and is sometimes even a complete loss. The lower leaves on the fruiting canes are attacked first. Defoliation is unusual but all the leaves (except the very youngest) may dry up and remain on the canes. Even partial loss of foliage on fruiting canes materially lessens the quality of the fruit making it noticeably insipid.

Red spiders have been found in plantations during all of the time the leaves are on the canes though in some cases they may only be located after a careful search.

Injury to Black Currant

An outbreak of red spider on black currants may cause complete defoliation. Defoliation may begin shortly before the fruit is picked and does not injure the current season's crop to the same extent as with raspberries. It must, however, be a serious drain on the bushes and indirectly injure the crop of the following season.

Causes of Outbreaks on Raspberry

Two conditions seem to be necessary to bring about an outbreak of red spider on raspberry. First, a protracted period of hot weather, say two weeks or more with a daily mean temperature of around 70° F. unaccompanied by heavy washing rains. Second, entire absence or presence in insufficient numbers of natural enemies. An outbreak was noted in a small plantation on July 12, 1928, and at that date had reached the stage where considerable injury had already been done. For a period of 19 days —that is from June 24 to July 12, the average temperature was 72.7° F. A high relative humidity does not seem to be directly unfavorable to the mites themselves for during the period mentioned above the humidity was about 76.4 per cent.

Control

One of the most common enemies of the red spider is a pale mite (identified by H. E. Ewing as *Seius* sp., probably *pomi* Parrott). This mite has been noticed wherever red spider (and some other mites) were found. The rapidity with which it can destroy a red spider egg is astonishing. All active forms of red spider are attacked by this mite which sucks out the body juices of its victims, but the adults are usually left alone if there is a supply of eggs and immature forms to feed upon. This predaceous mite is very active and can easily catch red spiders attempting to escape from it. The eggs, which are oval and much larger than the red spider eggs, are laid amongst colonies of red spiders and the young mites are predaceous also.

Among other natural enemies are the larvae of a cecidomyid, identified as *Feltiella venatoria* Felt, a species of *Triphleps*, and a small beetle probably *Stethorus punctum* Lec. Syrphid larvae have, also, been occasionally found in red spider colonies.

Lime sulphur at a strength of 1-40 is effective against red spider, but it cannot be used with safety on raspberry. A few experiments were conducted in the hope of finding a substitute not injurious to raspberry foliage. Derrisol was tried at a strength of 1-800 (the strength advised by the makers) plus 1 lb. of fish oil soap per 40 gallons. This had practically no effect on the red spider. Finely powdered derris at the rate of 2 lbs. per 40 gallons of water plus 1 lb. of soap gave some results but the mites very soon same back. The derris left on the leaves apparently had no toxic effect on the mites. It was noted that often the mites actually preferred parts of the leaf where particles of derris were thickest. Eggs laid under such conditions hatched normally and the immature forms were able to develop. This was even true where the dry derris particles were so thick as to almost obscure the leaf tissue. The fish oil soap was used as a spread-

er. In order to find out if it had any effect on the spiders, a spray composed of 5 lbs. of the soap in 40 gallons of water was tried. It had little or no effect on the mites.

Volck oil (a commercial preparation) was tried at a strength of 1 per cent. plus 1 lb. of soap per 40 gallons of the mixture. This spray killed 100 per cent., destroying even eggs and quiescent forms. It did not ordinarily injure raspberry foliage but it has a tendency to penetrate the leaf tissue and under drought conditions might cause injury. This oil has not been given sufficient trial as yet. Volck is a stable emulsion of a highly refined mineral oil and is expensive. It seems that an oil is highly effective against the red spider and a cheap form which will not injure foliage is highly desirable. Accordingly, a 1 per cent. raw cod oil emulsion was tried. This proved effective against the mites but was inclined to be injurious to the foliage. Further experiments with similar materials should be worth while.

THE APPLE MAGGOT OUTBREAK OF 1926 TO 1928

L. CAESAR, O.A.C. GUELPH

INTRODUCTION

The apple maggot (*Rhagoletis pomonella* Walsh) is a native insect, which originally fed upon haws and possibly some other wild fruits but, on the introduction of the apple, largely deserted the haws for this more attractive new fruit, just as in Europe the corn borer deserted its native food plants for corn after the latter had been introduced.

A GREAT POTENTIAL MENACE

There are few insects better adapted for causing the destruction of the apple crop than the apple maggot, as can be seen from the following facts:

(1) The adults do not all emerge at the same time, but continue to come forth over a period of six weeks or more, thus giving them a better chance to escape destruction from unfavorable weather conditions.

(2) Each female is capable of laying a large number of eggs.

(3) The eggs are placed beneath the surface of the apple, where they are safe from enemies and from unfavorable weather.

(4) The larvae feed within the fruit until fully grown and so are secure against natural enemies.

(5) When ready to emerge the larvae at once endeavor to work their way into the ground and, once in, change to the puparial stage and remain there until about July, when the adults emerge. Thus they have the protection of the soil covering.

(6) There is very little parasitism of any stage, the only parasite known seems to be very scarce in Ontario. It is true that a few predaceous enemies as ants, spiders and ground beetles at times destroy a considerable number of larvae while trying to enter the ground, and also capture some of the newly emerged adults before their wings are developed, but the total losses from these causes are small.

The fact that much greater damage has not been done in the past must be attributed chiefly to unfavorable environment brought about almost entirely by weather conditions.

Losses in the Past

There is no doubt that the insect has been present for a great many years in all our main apple growing districts, though I had never been able to find it in the Georgian Bay district until this fall. Yet, so far as I can learn, there has never been a general outbreak in the province until the present one, which began in 1926 and still continues. There have, however, been many local outbreaks; for instance, one year there was one near Kemptville, another year one a little west of Brockville, other years they have occurred in Prince Edward and Northumberland and on a smaller scale in Norfolk, Brant and Peel. In none of these were all or nearly all the orchards for more than a radius of a few miles involved. Moreover in the past very rarely were orchards, which had been well sprayed for codling moth at the so-called calyx spray, severely infested, evidently because sufficient poison remained on the foliage or fruit to kill most of the flies before they could lay their eggs. It is clear, therefore, that natural factors have until recently held the insect remarkably well in check.

The 1926 to 1928 Outbreak

The first intimation I received of this outbreak was from the spray supervisor in Prince Edward County. This man, Mr. Leslie Smith, had had remarkable success in his work of directing and supervising the spraying of the numerous orchards in his county which were in the spray service.

In the fall of 1926 before picking began he was looking over the orchards and feeling deservedly gratified at the high degree of success in controlling the apple scab and codling moth until he observed, to his dismay, that many of the orchards were severely attacked by the apple maggot and in several cases their whole crop ruined. There had of course been some apple maggot present the previous year, but the owners had not thought it abundant enough to be worth mentioning to the spray supervisor and so no special spray for it had been given.

The same state of affairs happened that year, but to a less extent, in Northumberland and parts of Peel and Ontario counties.

In 1927 all these orchards, so far as the spray supervisors knew of them, were given the special spray or sprays recommended by us for the apple maggot and were saved from any serious loss, but in unsprayed orchards the insect was still very destructive. In the meantime in Norfolk and several other counties the pest had become very abundant.

So bad was it in Norfolk in 1927 that a number of large and valuable orchards lost their total crop and the work of the insect could be found in practically every orchard. The spray supervisors and the managers of the Co-operative Fruit Association realized that unless control measures in 1928 were successful they would probably lose their market for apples. Consequently in 1928 my assistant, Mr. Thompson, was stationed there to watch for the earliest emergence of the insect and to tell the growers when to begin spraying for it. Wherever they did as directed the crop was saved, but, wherever no special spray was given, the maggot occurred in large numbers and again ruined most of the crop. In addition it had this year begun to work havoc in some of the best orchards in Huron county, where it had never before, so far as I know, been very destructive. I also found it this year for the first time in any appreciable numbers in several cared-for orchards not situated in the so-called fruit districts. Thus you can see that the outbreak has been very wide, almost province wide, and that there is reason to believe that but for the knowledge which had previously been gained in the studies of the insect, Ontario would probably have suffered a great calamity in 1927 and 1928; for left unaided the growers would not have known how to combat the insect.

Causes of the Outbreak

Causes of outbreaks are often not easy to determine but I feel almost certain that the outbreak of the apple maggot the last three years can be attributed directly to the abnormal weather conditions which prevailed these seasons. You will remember that there has been much more moisture the last three years than usual. With moistrue, as is usually the case, there has been a lower temperature much of the time. The question then is how could the greater amount of moisture and a lesser extent lower temperature, account for the outbreak. The following seems to me to be the answer.

1. If the ground is moist and soft during July and early August when the adults are emerging from it, many will be able to do so, which in a dry season, when the ground was hard and baked, would have been unable to work their way through the surface and thus would have perished.
2. After emerging the flies must have moisture to feed upon, otherwise they will live only a few days and will therefore lay but few eggs (Egg laying does not begin until nearly a week after emergence). Now in a normal season the absence of dews most nights in July and August and the occurrence of rains only at considerable intervals must exert a great influence in holding the insect in check, whereas frequent rains with an unusual number of dewy mornings must give the insect a great opportunity to thrive and lay numerous eggs.

In this connection it is worth mentioning that the great outbreak of aphids last year and the consequent abundance of honey-dew furnished the flies with a liberal and nourishing supply of food ready to hand and may have been one of the factors responsible for the great amount of damage done. The abundance of the aphids themselves can, of course, be largely attributed to the moistness and coolness of the season.

3. The more rain there is the faster the poison of the calyx spray is washed off and therefore the less effective this spray is in preventing an outbreak. It is important also to note that in a cool season like the last two, at least, have been the flies came out much later than normal though the calyx spray was only a few days later. Hence the interval between this spray and the emergence of the flies was increased. This year Mr. Thompson after much searching found the first fly in Norfolk on July 12 and general emergence there did not begin until July 18, which was almost three weeks later than normal. The calyx spray was largely over by June 1st so that there were six weeks of an interval for this spray to be washed off. (Perhaps I should make clear that usually the calyx spray is the last one given in which poison is used).

4. A soft condition of the soil in fall due to moisture enables the larvae, after leaving the apples, to enter the earth easily and quickly and so not only escape lurking enemies but also find the best situation in which to winter and remain until the emergence of the adults the next summer. If the soil is hard many larvae either perish before they can enter it or are forced to become puparia beneath rubbish or grass where they are likely to perish from desiccation.

The above in my opinion are possible explanations of the unusual outbreaks that this province has just witnessed. In conclusion let me say that in conversation recently with the spray supervisors in the worst infested counties they assured me that our recommendation to spray the whole orchard with arsenate of lead as soon as the flies began to appear and again lightly two weeks later had given almost 100% control.

SIX YEARS' STUDY OF THE LIFE HISTORY AND HABITS OF THE CODLING MOTH (*Carpocapsa pomonella* L.)

J. Allan Hall, Dominion Entomological Laboratory, Vineland Station, Ont.

Introduction

This paper is based on codling moth studies conducted in the vicinity of Vineland Station, Ontario, during the years 1923 to 1928 inclusive.

Life-History Summary.—The winter is spent as full grown larvae in cocoons chiefly under rough bark, on the trees, or among debris on the soil. Pupation begins in late April and is followed by the emergence in June and July of the spring brood moths which give rise to the first eggs of a new generation. Of the larvae arising therefrom, about 88% over-winter and the balance transform to pupae and later to adults which emerge during late July, August and early September. These moths deposit eggs on the fruit during August and the first half of September. These in turn give rise to the larvae of a second generation which mature in October and November and then hibernate.

LIFE-HISTORY OF THE CODLING MOTH

Overwintering Larvae

The overwintering larvae consist of all non-transforming larvae of the first generation and the complete second generation. The larvae pass the winter in cocoons located under the rough bark of trees, in cracks and crevices in crates and storehouses, and among debris on the soil. They are inactive until spring, when, during the first warm days, they remodel their cocoons and furnish them with exit tubes which facilitate the emergence of the adults. A few of them migrate to new quarters and build new cocoons.

Pupation.—On an average the wintering larvae begin to transform to pupae about the end of April or a little before the apple leaf-bud tips show green. The maximum number pupate during the period between the cluster bud stage and the time the calyces close, and the last ones when apples average about 1½ inches in diameter. The dates are shown below in table No. 1.

Table 1.—Time of Pupation of Wintering Larvae.

Year	No. Observed	Date of Pupation First	Maximum	Last
1923	39	May 21	June 18	July 28
1924	172	Apr. 29	June 20	July 25
1925	706	Apr. 10	June 4	July 16
1926	714	May 2	May 17	July 10
1927	394	Apr. 19	May 20	July 7
1928	578	Apr. 29	May 10	July 19
6 yr. ave.	2603	Apr. 28	May 30	July 13

Pupal Period of Overwintering Generation.—Table 2 records the length of the pupal stage of 2,581 pupae, the first of which pupated on April 10 and the last on July 25. Due to a lower average daily temperature

the pupal period of those that pupated early in the season is considerably longer than that of those which pupated later. Early in the season the majority of the pupae are males and for this reason males have a longer period than females. The average length of the pupal stage was found to be 29.5 days, the maximum 52, and the minimum 8.

Table 2.—Pupal Period of Overwintering Generation.

Year	Sex	No. Observed	Total Days	Days Pupal Period Max.	Min.	Ave.
1923	Male	6	92	18	14	15.3
	Female	11	168	19	11	15.3
	M. & F.	17	260	19	11	15.3
1924	Male	72	1915	48	18	26.6
	Female	100	2700	46	14	27.0
	M. & F.	172	4615	48	14	26.9
1925	Male	366	8290	49	8	22.7
	Female	340	7587	45	8	22.3
	M. & F.	706	15877	49	8	22.5
1926	Male	349	11426	45	18	32.7
	Female	365	11931	45	11	32.7
	M. & F.	714	23357	45	11	32.7
1927	Male	210	7023	51	17	33.4
	Female	184	5553	52	17	30.2
	M. & F.	394	12576	52	17	31.9
1928	Male	281	9469	49	15	33.9
	Female	297	10042	47	15	33.7
	M. & F.	578	19511	49	15	33.75
6 yrs.	Male	1284	38215	51	8	29.7
	Female	1297	37981	52	8	29.3
	M. & F.	2581	76196	52	8	29.5

Emergence of Moths From Hibernating Larvae.—Soon after the apples come into full bloom the adults begin to emerge. They continue to do so in increasing numbers until the peak of emergence is reached about on week after the calyces close, and in decreasing numbers until emergence is finished, usually about the end of July. As commonly occurs among insects, males appear before females and are in the majority during the first half of the emergence period. Females assume the majority for the second half of the period and also of the total number emerging. During six years, 5,525 moths were observed, and of these 48% were males and 52% females. Tables 3 and 4 record the sex ratio, time of emergence and the correlation between the emergence and time of blooming of the apple.

Table 3.—Spring Emergence and Sex Ratio.

Year	No. Observed Male	Female	Date of Emergence Day and Month 1st	Max.	Last	Sex Ratio % M.	% F.
1923	17	18	5/6	3/7	14/7	48.6	51.4
1924	383	513	14/6	9/7	4/8	42.7	57.3
1925	879	934	20/5	5/6	5/8	48.5	51.5
1926	440	442	31/5	29/6	26/7	49.9	50.1
1927	567	565	29/5	22/6	27/7	50.0	50.0
1928	387	380	30/5	7/7	30/7	50.5	49.5
6 yrs.	2673	2852	1/6	26/6	28/7	48.4	51.6

Table 4.—Time of Bloom and Relation to Emergence.

Year	Date of First Bloom	Date of Full Bloom	Calyces Closed	Date of Emergence First	Date of Emergence Max.	Date of Emergence Last
1923	?	June 1	June 20	June 5	July 1-7	July 14
1924	May 26	" 3	" 20	" 14	" 9	Aug. 4
1925	" 14	May 22	" 9	May 20	June 3-7	" 5
1926	" 24	June 2	" 21	" 31	" 29	July 26
1927	" 16	May 27	" 17	" 29	" 22	" 27
1928	" 19	" 26	" 15	" 30	" 7	" 30
6 yrs.	" 19	" 29	" 17	June 1	" 28	" 28

Oviposition by Moths of the Spring Emergence.—Table 5 (a, b and c) records the observations made on oviposition. The data in this table may be summarized as follows: The average number of days before oviposition was 3.7, the maximum 11 and the minimum 0. The average number of days of oviposition was 5.3, the maximum 16 and the minimum 1. The post-oviposition periods ranged from 12 to 0 and averaged 2.6 days.

Table 5.—Oviposition by Moths of Spring Emergence.

(a) Pre-oviposition Period.

Year	No. of Females Observed	Total Days	Pre-oviposition Period in Days Max.	Min.	Ave.
1923	5	25	7	4	5.0
1924	20	62	5	2	3.1
1925	24	71	11	0	3.0
1926	31	120	8	1	3.9
1927	45	176	10	1	3.9
1928	31	125	10	1	4.0
6 yrs.	156	579	11	0	3.7

(b) Oviposition Period.

Year	No. of Females	Total	No. of Days Max.	Min.	Ave.	For the Generation 1st Eggs	Last Eggs	Days
1923	5	28	7	4	5.6	18.6	30.7	43
1924	15	60	9	1	4.0	25.6	10.8	47
1925	19	93	16	1	4.9	4.6	24.7	50
1926	19	78	14	1	4.1	23.6	5.8	44
1927	35	206	12	1	5.9	9.6	1.8	53
1928	17	119	13	1	7.0	8.6	1.8	54
6 yrs.	110	584	16	1	5.3	11.6	1.8	49

(c) Post-oviposition Period.

Year	No. of Females	Total Days	Max.	No. of Days Min.	Ave.
1923	No records				
1924	No records				
1925	19	51	7	1	2.7
1926	19	49	7	0	2.6
1927	33	70	7	0	2.1
1928	17	60	12	1	3.5
4 yrs.	88	230	12	0	2.6

NUMBER OF EGGS PER MOTH.—In captivity 184 females laid 11,844 eggs —an average of 64.4 each. The maximum number laid by one female was 234. There were several females that laid no eggs.

Table 6.—Number of Eggs Laid per Female.

Year	No. of Females	Total No. of Eggs	No. of Eggs per Female Max.	Min.	Ave.
1924	33	2653	168	18	80.4
1925	23	941	173	3	40.9
1926	43	2310	172	0	49.1
1927	47	3482	138	13	74.0
1928	38	2458	234	12	65.0
5 yrs.	184	11844	234	0	64.4

LENGTH OF LIFE OF MOTHS.—The dead moths in the oviposition cages were removed daily, their sex determined, and the length of their life computed. The results of observations on 412 males and 277 females, or a total of 689 moths are given in table 7. The average length of life of male moths was 7.6 and of females 10.2 days. The maximum and minimum periods for both sexes were 23 and 1 days respectively.

Table 7.—Length of Life of Moths of the Spring Generation.

Year	Moths Sex	No.	Total Days	Length of Life in Days Max.	Min.	Ave.	M. & F. Ave.
1924	M	57	337	18	1	5.9	
	F	27	262	18	4	9.7	7.1
1925	M	45	275	21	2	6.1	
	F	96	826	22	2	8.6	6.9
1926	M	118	749	17	1	6.3	
	F	51	467	20	3	9.2	7.2
1927	M	122	1039	23	2	8.5	
	F	65	717	22	3	11.0	9.0
1928	M	70	749	22	3	10.7	
	F	38	560	23	3	14.7	12.1
5 yrs.	M	412	3149	23	1	7.6	
	F	277	2832	23	2	10.2	8.7

THE FIRST GENERATION

EGGS OF THE FIRST GENERATION

TIME AND PLACE OF EGG DEPOSITION.—Shortly before the calyces become closed the first eggs are deposited on the leaves. The peak of deposition is reached four weeks later at which time the fruits average 1¼″ to 1½″ in diameter. At this time the eggs are deposited on both leaves and fruit. The last eggs are deposited about the time that apples average 2″ in diameter. The approximate average dates of deposition are: First eggs June 15, peak July 14 and last eggs August 2nd. See table 8 below.

Table 8.—Relation between Closing of Calyces and Deposition of Eggs.

Year	Date Calyces Closed	Date of Deposition First	Max.	Last
1923	June 20	June 12	?	July 30
1924	" 20	" 21	July 18	Aug. 12
1925	" 9	" 4	" 5	July 24
1926	" 21	" 22	" 19	Aug. 5
1927	" 17	" 12	" 15	July 30
1928	" 15	" 18	" 11	Aug. 1
6 yrs.	" 17	" 15	" 14	Aug. 2

INCUBATION PERIOD.—The incubation period of the eggs depends largely on the temperature. In the early part of the season the period is as long as 16 days, while in the warmer weeks it is as low as 6 days. Table 9 gives 8.6 days as the average time required by 192 groups of eggs.

Table 9.—Incubation Period of First Generation Eggs.

Year	No. of Groups	Total Days	Period in Days Max.	Min.	Ave.
1923	?	?	9	7	8.0
1924	19	143	11	6	7.5
1925	28	252	14	6	9.0
1926	40	320	12	6	8.5
1927	50	436	15	6	8.7
1928	55	509	16	6	9.2
5 yrs.	192	1660	16	6	8.6

LARVAE OF THE FIRST GENERATION

TIME OF HATCHING.—About a week after the calyces are closed the first larvae appear. The hatching peak comes three to four weeks later (mid-July) and the last eggs hatch about the end of the second week in August. Table 10, below, gives June 25, July 21 and August 10 as the average for the first, peak and last hatching dates for this generation.

Table 10.—Hatching of First Generation Larvae.

Year	Dates of Hatching First	Peak	Last	Period for the Generation
1923	June 21	?	Aug. 5	47 days
1924	July 2	July 26	" 20	50 "
1925	June 13	" 14	July 31	49 "
1926	" 29	" 27	Aug. 12	45 "
1927	" 25	" 22	" 15	51 "
1928	" 27	" 18	" 8	42 "
6 yrs.	" 25	" 21	" 10	46 "

LENGTH OF FEEDING PERIOD; (STOCK-JAR METHOD).—The length of the feeding period of 1,122 hibernating larvae (both transforming and non-transforming) is given in table 11. The first larvae entered the fruit June 21 and the last on August 20. The average length of feeding period was 27.1 days, with a maximum of 73 and a minimum of 12. The periods were about equal in Duchess, Wealthy, Greening and Baldwin apples.

Table 11.—Feeding Period of Larvae in Fruit.

Year	No. Reared	Total Days	Period in Days Max.	Min.	Ave.
1924	25		56	23	35.9
1925	27	5720	52	21	32.4
1926	124		73	20	31.8
1927	294	9022	57	17	30.7
1928	652	15694	40	12	24.0
5 yrs.	1122	30436	73	12	27.1

COCOONING PERIOD OF TRANSFORMING LARVAE.—This period is considered as extending from the time the larva leaves the fruit until it has pupated. Table 12 gives a range of 24 to 1 with an average of 6.1 days for 455 larvae.

Table 12.—Cocooning Period of Transforming Larvae.

Year	No. of Larvae	Total Days	Cocooning Period in Days Max.	Min.	Ave.
1925	149	879	12	1	5.9
1926	71	533	24	2	7.5
1927	55	341	14	1	6.2
1928	180	1021	15	1	5.6
4 yrs.	455	2774	24	1	6.1

Per Cent. that Pupate and Time of Pupation.—About 88% of the larvae remain in their cocoons until the following spring, or, under certain conditions, may remain as larvae until the second year. (We have had them do the latter in the insectary). After an average resting period of 6.1 days, the other 12% pupate and give rise to adults. Table 13, below, shows that on the average these larvae begin to pupate on July 21, and that pupation continues over a period of 5 weeks.

Table 13.—Per cent. that Pupated and Time of Pupation.

Year	No. of Larvae	Pupated No.	%	Date of Pupation First	Max.	Last
1923	722	109	15.1	July 16	Aug. 1	Aug. 21
1924	2590	116	4.5	" 29	" 7	" 29
1925	316	138	44.0	" 7	July 26	" 13
1926	135	7	5.2	" 28	Aug. 7	" 25
1927	294	15	5.1	" 26	" 1	Sept. 2
1928	850	187	22.0	" 19	" 2	Aug. 19
6 yrs.	4907	572	11.6	" 21	" 2	" 23

Length of Pupal Stage.—As shown in table 14 (below) the average length of the pupal period for each sex is 15.3 days, with a maximum of 28 for females, 23 for males and a minimum of 10 days each. The average length of the period for this generation is approximately only half as long as the average for the overwintering generation (15.3 and 29.5 days each respectively).

Table 14.—Length of Pupal Stage—First Generation.

Year	Sex	No.	Total Days	Pupal Period Max.	Min.	Ave.	Ave. Both Sexes
1924	M	45	813	23	14	18.1	17.7 days
"	F	61	1061	28	11	17.4	
1925	M	67	974	18	11	14.5	14.8 "
"	F	72	1083	19	12	15.0	
1926	M	24	374	20	13	15.6	15.7 "
"	F	40	632	21	13	15.8	
1927	M	28	477	22	13	16.8	16.9 "
"	F	39	658	22	14	17.0	
1928	M	73	979	17	10	13.4	13.3 "
"	F	94	1250	17	10	13.3	
5 yrs.	M	237	3617	23	10	15.3	15.3 "
"	F	306	4684	28	10	15.3	

MOTHS OF THE FIRST GENERATION

Time of Emergence and Sex Ratio.—During the six years, as shown in Table 15, July 19 and September 26 were the earliest and latest dates upon which first generation moths emerged, and August 4, August 17 and September 14 the average dates of first, maximum and last emergence.

The sex ratio of 797 moths was 43.4% males, and 56.5% females.

Table 15.—Time of Emergence and Sex Ratio—First Generation Moths.

Year	Date of Emergence First	Max.	Last	No. Observed M.	F.	Sex Ratio % M.	% F.
1923	July 31	Aug. 13	Sept. 10	81	115	41.3	58.7
1924	Aug. 15	" 25	" 26	46	61	43.0	57.0
1925	July 19	" 17	Aug. 27	67	72	48.2	51.8
1926	Aug. 12	" 16	Sept. 13	24	46	34.3	65.7
1927	" 5	" 15	" 20	48	54	47.0	53.0
1928	" 2	" 15	" 17	80	103	43.7	56.3
6 yrs.	Aug. 4	" 17	Sept. 14	346	451	43.4	56.6

As shown in table 15, there is a very considerable variation in the time and duration of emergence of the first generation moths.

Oviposition.—The oviposition period begins about two weeks before, and ends about three weeks after the Duchess apples ripen. All the eggs are laid on the fruit. Table 16 (a, b and c) gives the data obtained, a summary of which is as follows: The pre-oviposition periods ranged from 1 to 9 and averaged 2.6 days. The oviposition periods ranged from 1 to 13 and averaged 5.2 days. The post-oviposition periods varied from 1 to 16 and averaged 3 days.

Table 16.—Oviposition Period—First Generation Moths.

(a) Pre- oviposition Period

Year	No. of Females	Total	Days Pre-oviposition Period Max.	Min.	Ave.
1923	9	25	5	1	2.7
1924	8	18	3	1	2.2
1925	16	37	4	1	2.0
1926	5	18	5	2	3.6
1927	20	66	9	1	3.3
1928	13	26	4	1	2.0
6 yrs.	73	190	9	1	2.6

(b) Oviposition Period

Year	No. of Females	Total	No. of Days Max.	Min.	Ave.	For the Generation First	Last	Days
1923	9	31	6	2	3.4	July 28	Sept. 15	50
1924	7	33	13	2	4.7	Aug. 19	" 25	38
1925	12	53	8	1	4.8	" 3	Aug. 31	29
1926	3	11	4	3	3.6	" 15	Sept. 8	24
1927	10	73	13	3	7.3	" 10	" 20	41
1928	10	60	12	3	6.0	" 4	" 16	43
6 yrs.	51	266	13	1	5.2	" 8	" 14	37

(c) Post-oviposition Period

Year	No. of Females	Total	Max.	No. of Days Min.	Ave.
1923 and 1924 no records					
1925	13	35	8	1	2.6
1926	3	7	3	1	2.3
1927	10	45	16	1	4.5
1928	10	24	5	1	2.4
4 yrs.	36	111	16	1	3.0

Fecundity of Females.—Table 17 shows that 57 moths laid a total of 4,741 eggs, or an average of 83.2 each, with a maximum of 208 and a minimum of 2 eggs per female.

Table 17.—Fecundity of Females.

Year	No. of Females	Total No. of Eggs	No. of Eggs per Female Max.	Min.	Ave.
1923	8	657	143	46	82.1
1924	8	856	203	36	107.0
1925	9	741	179	12	82.3
1926	3	145	83	5	48.3
1927	19	1456	163	2	77.0
1928	10	886	208	52	88.6
6 yrs.	57	4741	208	2	83.2

Length of Life of Moths.—Table 18 gives a summary of records for 169 males and 117 female moths. The average length of life of males was 5.4 days, and of females 9.6 days; the maxima were, males 21 days, females 25 days; the minimum for each sex was 1 day.

Table 18—Length of Life—First Generation Adults.

Year	Sex	No.	Total Days	Length of Life in Days Max.	Min.	Ave.	Both Sexes Ave.
1923	M	37	163	8	2	4.4	5.1
	F	22	141	21	2	6.4	
1924	M	28	177	19	2	6.3	7.2
	F	12	112	22	4	9.3	
1925	M	39	233	14	2	6.1	7.4
	F	34	306	15	1	9.0	
1926	M	18	46	13	3	8.2	5.0
	F	8	50	10	1	4.2	
1927	M	26	132	21	1	7.0	11.0
	F	27	383	25	4	14.0	
1928	M	21	156	17	2	7.4	8.2
	F	14	132	15	4	9.4	
6 yrs.	M	169	912	21	1	5.4	7.1
	F	117	1121	25	1	9.6	

Life Cycle of First Generation.—The complete life cycle is here considered as the time required to complete all stages from egg to egg. The summarized averages in days are: Incubation period 8.5; larval feeding period 27.1; cocooning period 6.1; pupal period 15.3; pre-ovipoition period 2.6. Complete cycle 59.7 days.

THE SECOND GENERATION

Eggs of the Second Generation

Incubation Period.—Table 19 is a record of the incubation periods of 92 groups of eggs laid on various dates from July 28 to September 25 during a period of six years. Those laid late in the season required a much longer time owing to lower daily mean temperatures. The time required varied from 6 to 26 and averaged 9.5 days.

Table 19.—Incubation Period—Second Generation.

Year	No. of Groups	Total Days	Period in Days Max.	Min.	Ave.
1924	8	86	26	6	10.8
1925	13	117	12	7	9.0
1926	6	62	10	6	10.3
1927	22	234	14	8	10.6
1928	41	372	25	6	9.0
5 yrs.	92	871	26	6	9.5

Larvae of the Second Generation

Time of Hatching.—The periods of hatching of eggs of the second generation (Table 20) in the different years, began as early as August 3 and ended as late as October 15, the average duration of the period being 43.5 days and the average dates being August 15, August 30 and September 28 for the first, peak and last hatch respectively.

Table 20—Time of Hatching—Second Generation Larvae.

Year	First	Dates of Hatching Peak	Last	Period in Days
1923	Aug. 3	Aug. 24	Sept. 24*	5
1924	" 27	Sept. 5	Oct. 15	49
1925	" 10	Aug. 26	Sept. 10	31
1926	" 25	Sept. 5	Sept. 15*	21
1927	" 15	Aug. 29	Oct. 1 or later	47
1928	" 11	?	Oct. 11	61
6 yr. Ave.	" 15	Aug. 30	Sept. 28	43.5

*Estimated from oviposition dates.

Length of Feeding Period, (stock-jar method).—These larvae feed from 14 to 76 days and average 37.4 days in the fruit. They are found leaving it during September, October and the early part of November. Some fail to mature owing to low temperatures late in the season. Table 21 gives the summarized data.

Table 21.—Length of Feeding Period—Second Generation Larvae.

Year	No. of Larvae	Total Days	Length of Period in Days Max.	Min.	Ave.
1924	21	1086	75	28	51.7
1925	27	909	51	23	33.6
1926	20	695	54	14	34.7
1927	51	2099	76	29	41.1
1928	246	8878	72	16	36.0
5 yrs.	365	13667	76	14	37.4

Cocooning Period.—The second generation larvae do not transform to pupae until the following April, May and June, the cocooning period therefore average about seven months.

Life Cycle.—The life cycle average duration of the second generation is as follows: Incubation period 9.5 days; larval feeding period 37.4 days; cocooning period 21.0 days; pupal period 29.5 days; pre-oviposition period 3.7 days; total 290 days. The wintering first generation cycle averages 320 days.

Notes on the Habits of the Codling Moth

Feeding Habits of Larvae.—As soon as they are hatched the young larvae begin to move excitedly about seeking for fruits and easy places to enter them. Advantage is taken of any wounds, scars, places where a fruit touches another fruit or a leaf and of the calyces. In entering the fruit from the side the larvae bite out and discard any portions of the skin which they find it necessary to remove in order to gain an entrance, little if any of the material being ingested until they have reached the pulp. They have been observed to take as long as two hours to make a hole through the apple skin.

Attempts to rear larvae to maturity on a purely leaf diet have failed, though some caterpillars managed to exist for a period of 30 days.

PLACE OF ENTRY INTO UNSPRAYED FRUIT.—Tables 22 and 23 show that 57 per cent. of first generation, 82 per cent. of second generation, and 73 per cent. of the total entries are made in the side of the apple, and 43 per cent., 18 and 27 per cent. respectively are calyx entries.

Table 22.—No. of Entries Observed.

Year	First Generation Side	Calyx	Second Generation Side	Calyx	Both Generations Side	Calyx
1923	505	199	10371	2741	10876	2940
1924	5779	4080			5779	4080
1925	832	1002	7889	1309	8721	2311
1926	305	245	1321	147	1626	392
1927	102	123	564	181	666	304
1928	78	39	392	143	470	182
6 yrs.	7601	5688	20537	4521	28138	10209

Table 23.—Method of Entry into Unsprayed Fruit.

Year	First Generation % Side Entries	% Calyx Entries	Second Generation % Side Entries	% Calyx Entries	Both Generations % Side Entries	% Calyx Entries
1923	71.7	28.3	79.1	20.9	78.8	21.2
1924	58.5	41.5	?	?	66.3	33.7
1925	45.4	54.6	80.	20.	69.3	30.7
1926	54.5	45.5	90.	10.	81.3	18.7
1927	55.7	44.3	75.7	24.3	65.1	34.9
1928	66.7	33.3	73.3	26.7	68.8	31.2
Ave. 6 yrs.	57.2	42.8	81.9	18.1	73.3	26.7

SUSCEPTIBILITY OF VARIETIES TO CODLING MOTH ATTACK.—Records taken in an orchard at Vineland during the past six years show the following varieties to be susceptible, placing the most affected first, in the following order: Baldwin, Greening, Cranberry, Ontario, Hubbardston, Dudley, Wagener, Duchess and Jonathan.

TIME OF PUPATION IN RELATION TO LOCATION ON TREE TRUNK.—Usually pupation begins on the south side of the tree trunk, gradually spreads to the east and west and finally to the north side. While, in general, this may be considered due to the relative exposure to the sun's rays yet all larvae are not affected equally under the same conditions. For example, we find that with two larvae which matured at the same time and wintered side by side, one may pupate and emerge as an adult before the other pupates. Some larvae of the second generation transform as early as any of the overwintering larvae of the preceding generation.

HABITS OF THE ADULTS.—The greater part of adult activities takes place during the late evening hours. A few pairs have been observed mating during the daylight hours, and on one occasion a female was seen ovipositing on an apple about noon. Adults have not been observed feeding but they are attracted to sweet and fermenting solutions. 624 moths have been taken in bait solutions whereas in the same number and kind of containers, not one was taken in water.

The females deposit their eggs singly. Three or four eggs are sometimes found on one apple but seldom more than one on a leaf. Early in the season the majority are laid on the upper surface of the leaves, in midseason on the underside and, after the pubescence wears off, on the fruit.

Death in the case of males usually occurs shortly after mating and with females shortly after the completion of oviposition.

A BREEDING PLACE OF EUPHORBIA INDA, LINN, THE BUMBLE FLOWER BEETLE

G. J. SPENCER, UNIVERSITY OF BRITISH COLUMBIA

During the first two weeks of August of this year, Mr. Sands of the Department of Botany at the Ontario Agricultural College, took me for a drive along the north shore of Lake Erie in the region of the three Eriaux of Kent County. Shortly after passing Eriau Park he stopped along the trail to point out a series of nearly contiguous nests of the Pismire mound-building ant, lying under the shore-fringing woods of mixed pine and oak, heavily festooned with thick stems of wild grape. The nests lay in an area of pure sand coloured to dull black by the presence of much leaf mould.

Idly and wantonly I seized a dry stick and obeyed the primitive instinct of disturbing the surface of a nest, to watch the hordes of ants hurry out. The nest occupied a miniature crater about a foot across, slightly sunken below the level of the surrounding ground and the disturbing stick in raking over the surface, opened up the margin of the crater by a gash about four inches deep and revealed several small typical scarabeid larvae. The ants in raging around, promptly fell upon them and immediately blotted them from sight.

Further prodding and digging showed that the margin of each crater contained scores of larvae in several sizes of instar, varying from quite small to probably mature, occupying an area from three to four inches outwards from the inner edge of the crater, and to a depth of some eight inches.

It seems unlikely that there was any commensalism in this relationship from the alacrity with which the ants pounced on the larvae as soon as the latter were uncovered. On the other hand, it is remarkable that the grubs should live in such numbers so close to the ants—in fact completely surrounding them (probably feeding on decaying vegetable matter or grass from the nests) and that the ants should apparently keep strictly to the confines of their crater-nests, or else they would discover the larvae. It may be that these ants are not normally carnivorous, that they are cognizant of the presence of the grubs, that some form of commensalism does occur and that their attack upon and overwhelming of, the larvae, was an effort of self-defence at finding their nests rudely torn open.

We managed to scoop about a dozen grubs out into the roadway and to pull the ants off them—then filling a tin can with the sandy mould occurring on the edge of the nests, we dropped in the grubs. Upon arriving at Chatham, I put a few tender leaves of domestic grape into the can and later some raspberry leaves. The grubs ate the membrane of the leaves, eating more raspberry than grape, and left the midribs and stalks. After a week's captivity they did no more eating and eight of them shrivelled and died. The rest seemed disposed to remain quiescent so I brought them to the coast where they were kept undisturbed, at room temperature in the sealed can.

To my delight, on October 14th., two fully-formed but small beetles of *Euphorbia inda* Linn., emerged from olive shaped pupal cases of sand grains cemented together. The pupal cases soon fell apart.

In the limited literature at my disposal, I find rotting wood only mentioned as the breeding place of beetles of *Euphorbia* genus and if the situation I have described above is new, it presents an interesting item for investigation.

NOTES ON THE BIOLOGY AND LIFE-HISTORY OF THE MEXICAN BEAN BEETLE IN ONTARIO

GEO. M. STIRRETT, DOMINION ENTOMOLOGICAL LABORATORY, CHATHAM, ONTARIO

The Mexican bean beetle, *Epilachna corrupta* Muls., was discovered for the first time in Canada at Cedar Springs, Ontario, on July 20, 1927.

THE SITUATION IN 1927

Following the discovery of the bean beetle at Cedar Springs the scouts of the federal Division of Foreign Pests Suppression discovered the insect at eight other locations in Kent county, six in Essex county, three in Halton county, and one each in York and Elgin counties. In addition to these places the Chatham laboratory staff found two other infestations in Essex county. Thus there was a total of 21 separate infestations known in 1927.

The degree of infestations and consequently the amount of injury effected during 1927 was very slight. The writer visited all of the infestations in Kent and Essex counties and observations made indicated that there was an average of about five plants destroyed in each infestation while the number of beetles, pupae, and larvae collected from all infestations throughout the season would total not over 1,000 individuals.

All stages of the insect were found in the field between July 20 when the first infestation was discovered, and August 23, the date of finding the last infestation. From a detailed study of the type of individuals present in each infestation it was found that the beetles initiating the infestations were present in Ontario not later than June 20 or between that date and June 26.

How, or when the first beetles came to Ontario is undetermined. Scouting in 1926 throughout the area found infested in 1927 did not bring to light any infestations, if such were present. It has been suggested that the beetles migrated by flight from Ohio or Michigan and this may or may not be true. It is, however, a well known fact that the beetles are strong fliers and observations made in New Mexico prove that flights of 10 or 18 miles or more are made in the spring and fall. The overwintering beetles leave hibernation about the middle of May in Ohio, (May 15 in 1928), and it would not be beyond reason for them to appear in Ontario about one month later.

THE SITUATION IN 1928

It was planned this year to start a detailed study of the life-history and control of the beetle. The study, however, was somewhat curtailed because all our hibernating adults had died and no material was available until found in the field.

Beginning on May 24, scouting in the parts of Essex and Kent counties found infested last year failed to reveal any stage of the insect. On June 27, however, one adult female and three egg clusters were found at Leamington near the location of an infestation of 1927. The adult was old and it is surmised that she was the parent of the eggs found as she subsequently laid four masses of fertile eggs before disappearing from her cage. A second visit to the place on August 4 yielded 24 newly emerged adults and eight egg clusters so that eggs must have been laid about 45 days previously, or about June 17. These larvae were missed in the first search of the field on June 27. No other infestations were found in Kent and Essex counties although frequent search was made throughout the season. Mr. H. E. Appleyard subsequently found three infestations in Norfolk county on

August 9, 10 and 23 respectively. During 1928, therefore, only four infestations were discovered in comparison with the 21 infestations found in 1927.

The infestation found on August 9 constituted the worst infestation so far found in Ontario. In a 10-acre field of white field beans, 207 plants showed injury. These were confined to an area of about three-fourths of an acre and scattered within this area at 51 places. The largest number of injured plants at one place was 13.

From a study of these four infestations it was determined that the beetles first appeared in the field about the same date as in 1927.

Life-History Studies During 1928

Material collected at Leamington (June 27) and at three other locations was taken to Chatham and reared in the insectary through two full generations.

It is not necessary to give the life-history in detail at this time, but the following facts secured through insectary rearings are of interest. It was found that the length of the preoviposition period for first generation adults was about five days and the duration of the egg-laying period varied from three to four weeks. The greatest number of eggs produced by one female was 275, contained in seven masses, while the average number of masses laid by one female was 3.07. The average number of eggs per mass, based on a count of 80 clusters, was 43. The greatest number in any one mass was 71 while the lowest number was 5.

The average incubation period based on 20 egg masses was 8.95 days. The shortest incubation period was seven days, while the longest was 12 days. 91.44 per cent. of the eggs hatched under insectary conditions.

The length of larval life varies considerably among individuals of the same brood and between individuals of the first and second generations, the latter larvae taking longer to develop.

The length of larval life in days and by instars is given below. The first generation data were secured mainly in the month of July, for which month the insectary hygrothermograph showed a mean monthly temperature of 70.6 degrees F. and a mean monthly relative humidity of 79.6 per cent. The second generation data were secured from August 17 to about September 26. The mean monthly temperatures for these months were 69.4 degrees F. and 56.0 degrees F. respectively, while the relative humidities were 79.7 per cent. and 78.9 per cent.

First Generation Larvae

Instar	No. of examples	Average length in days	Maximum length in days	Minimum length in days
1	39	4.02	6	3
2	35	5.02	9	2
3	56	5.69	11	3
4	53	6.56	10	4
Total		21.29	36	12

Second Generation Larvae

Instar	No. of examples	Average length in days	Maximum length in days	Minimum length in days
1	121	6.32	11	4
2	87	6.32	13	2
3	65	8.53	13	5
4	57	9.12	20	3
Total		30.29	57	14

The length of the pupal period also varies considerably, as is shown below. The data for the first generation pupae were secured during the last two weeks of July and the first week in August, while the data concerning the second brood of pupae were secured from September 26 to October 22. The mean monthly temperature and mean relative humidity, in the insectary, for the month of October was 50.05 degrees F. and 82.48 per cent. respectively.

	No. of examples	Average length in days	Maximum length in days	Minimum length in days
First generation pupae	53	9.32	11	8
Second generation pupae	60	21.66	24	15

The average length of time to complete the first generation in the insectary from egg to egg would be about 44.56 days while the average length of time required to complete the second generation would be about 60.90 days.

The General Life-History in Ontario

In conclusion, a generalized life-history of the Mexican bean beetle is outlined as it occurs at present in Ontario. This outline is possible through the correlation of field and insectary observations extending over a period of two seasons.

Adults that have passed the winter appear in the fields from June 17 to July 1 and begin to lay eggs on the early beans. It is not known at the present time where these adults originate. They may migrate by various means from Ohio and Michigan each year, or they may have spent the winter of 1927-28 in Ontario. It must be true that the orginal infestation in Ontario came from the United States, but by what means or at what date is unknown. Adults first appeared in Ontario about the same time in 1927 and 1928.

The earliest record of eggs is June 27 when three masses were found at Leamington. The eggs hatch in from seven to twelve days and the young larvae begin their destructive feeding. By July 15 most of the larvae have reached the fourth instar and by July 20 pupae begin to appear. In 10 days the first generation adults are to be found. This is generally about the beginning of August.

After five or six days eggs are again produced and these hatch about the period August 17 to 24. The new brood of larvae become full grown during the first two weeks in September and most of these are in the pupal stage the last two weeks of September. Adults emerge during the period October 3 to 22, or until cool weather kills the pupae. The adults are active until about the period October 12 to 31. In 1927 they went into hibernation on October 12, and in 1928 about October 30.

The adults of the first generation die shortly after depositing their eggs, nearly all being dead by September 27.

In the field it is very hard to follow the individual generations as the stages overlap considerably. One frequently finds members of the first and second generations present on the plants at the same time.

THE ENTOMOLOGICAL RECORD, 1928

NORMAN CRIDDLE, ENTOMOLOGICAL BRANCH, DOMINION DEPARTMENT OF AGRICULTURE

The decline in the number of new insect records during 1928 was very marked, and were it not for the co-operation of Messrs. Brown and Walley, the present "Record" would be exceedingly short. With their aid, however, we have been able to include distributional lists of two families of Coleoptera and three of Hemiptera. These lists are necessarily provisional and we look to our readers to fill in the omissions.

Among the larger systematic contributions published during the year the following are worthy of special note :

Principles of Systematic Entomology, by G. F. Ferris, 169 p.p., 1928, Stanford University Publications, Biological Sciences, Vol. V, No. 3. See review in the "Canadian Entomologist."

COLEOPTERA

Lepturini of America North of Mexico, Part 1, by J. M. Swaine and Ralph Hopping, 97 pp., 13 plates, 1928, National Museum of Canada, Bulletin 52, price 20 cents. This paper includes a revision of the genera of the subfamily. There are given keys to and descriptions of the species of the genera, *Pseudopachyta, Pidonia, Idiopidonia, Grammoptera, Alosterna, Pseudostrangalia, Leptura, Typocerus, Charisalia*, and *Anoplodera*. Notes on distribution and host plants are given.

Revision of the North American Species of Buprestid Beetles Belonging to the Genus Agrilus, by W. S. Fisher, 347 pp., 11 plates, 1928. U. S. National Museum Bulletin 145. This paper includes keys to and descriptions of the North American species of *Agrilus*. Notes on host plants and distribution are given. The male genitalia of most of the species are figured.

Review of the North American Species of Podabrus, by H. C. Fall. Published in "Entomologica Americana," VIII, 65-103, 1927. This paper includes keys to and descriptions of the species. Notes on distribution and relationships are given. —W. J. B.

HEMIPTERA

The Family Hydrometridae in the Western Hemisphere, (*Hemiptera*), by J. R. de la Torre Bueno (Ent. Amer., Vol. VII, N. S., No. 2, 1926). An excellent treatise on the North and South American species of Hydrometridae, including notes on the distribution, biology and taxonomy of the species.

Studies on the Biology of the Reduviidae of America North of Mexico, (*Hemiptera*), by P. A. Readio (Kan. Univ. Sci. Bull., XVII, Pt. 1, 1927). A presentation of the known data concerning the life histories and habits of the Reduviidae of America north of Mexico; essentially a biological treatise but includes keys and descriptions for the identification of the species discussed. The illustrations are excellent.

The Leafhoppers of Ohio, (*Homoptera*), by Herbert Osborn, (Ohio Biol. Surv. Bull. 14, Vol. III, No. 4, 1928). A treatment of the species of Cicadellidae native to Ohio. The paper includes keys for the identifcation of the species, notes on their distribution, host plants and economic importance with figures of the nymphs and adults.

A Monographic Study of the Hemipterous family Nabidae as it Occurs in North America, (*Hemiptera*), by Halbert M. Harris (Ent. Amer., Vol. IX, N. S., Nos. 1 and 2, 1928). Synoptic keys, descriptions and biological notes for all the species of Nabidae known to occur in North America, including Central America and the West Indies.—G. S. W.

DIPTERA

The Mosquitoes of the Americas, by Harrison G. Dyar, Carnegie Institution of Washington, Publication No. 387 (616 pages and 123 plates), May, 1928. This publication is a treatise on the Culicinae of North and South America. In addition to North American species, the author has included all the known species of the whole South American continent and has endeavoured to bring the specific synonomy up to date. The volume contains adequate keys and more than 400 illustrations revealing generic and specific characters. It should prove a valuable and indispensable addition to the libraries of all students of the Culicidae.

HYMENOPTERA

Biological and Taxonomic Investigations on the Mutilled Wasps, by C. E. Mickel, Bull. 143, U. S. National Museum, 1928. This is an important contribution to an exceedingly interesting group of insects. It includes taxonomic descriptions and much biological detail including a list of the known hosts of these wasps.

NOTES OF CAPTURES

Species preceded by an asterisk (*) described since the previous "Record" was prepared.

LEPIDOPTERA

Satyridae

* *Oeneis bore* sub-sp. *hanburi* Watkins. Gray's Bay, Corination Gulf, (David Hanbury); Cambridge Bay, Victoria Island, (Capt. Collinson). Also from same general locality in 1851 by Sir John Richardson.

Ann. Mag. Nat. His., 10 Ser., Vol. 151, No. 5, 1928.

Nymphalidae

* *Brenthis myrina* ab. *jenningsae* Holland. Thunder Bay, Ont., (O. E. Jennings).
* *Brenthis myrina* sub-sp. *terrae-novae* Holland. Newfoundland, (T. L. Meade).
* *Brenthis albequina* Holland. White Horse Pass, Y. T., (W. F. O. Baxter).
* *Brenthis bellona* ab. *toddi* Holland. St. Margarits River, Labrador.
Ann. Carnegie Mus., XIX, No. 1, 1928.
* *Aglais antiopa* var. *hypoborea* Gonner. Alaska.
Ent. Zeitschr., 41, 1928.

Noctuidae

Anomogyna homogena McD. Hopedale, Labrador. ....
* *Graptolitha thaxteri* race *alaskensis* Barnes. Chatanika, Alaska.
* *Graptolitha thaxteri* race *rosetta* Barnes. New Westminster and Vancouver, B. C.
Xylotype acadica B. & B. Hopedale, Labrador.
* *Zanclognatha jacchusalis* race *bryanti* Barnes. Wellington and Duncans, B. C., (T. Bryant).
The new species in Pan. Pac. Ent., Vol 8, 1928.

Eucosmidae

Eucosma ragonoti Wlshm. Aweme, Man., 12, VII, 1928. (N. Criddle).

COLEOPTERA

Prepared by W. J. Brown

The following list includes the records of Mr. F. S. Carr and Mr. J. B. Wallis and of the National Collection. Species described as new in the "Canadian Entomologist" have been omitted as usual. In the case of species described as new in other publications, citations are given to the original descriptions. The arrangement of the names is that of Leng's Catalogue of Coleoptera.

Carabidae

162 *Sphaeroderus lecontei* Dej. Vivian, Man., (Wallis).
603 *Bembidion salinarius* Csy. Medicine Hat, Alta., (Carr).
873 *Lebia atriventris* Say. Aweme and Transcona, Man., (Wallis).
1162 *Poecilus lucublandus* Say. Saskatoon, Sask., (King).
1243 *Curtonotus carinatus* Lec. Saskatoon, Sask., (King).
1435 *Amara scitula* Zimm. Medicine Hat, Alta., (Carr).
1438 *Amara remotestriata* Dej. Medicine Hat, Alta., (Carr).
1472 *Badister bipustulatus* Fab. Medicine Hat, Alta., (Carr).
1691 *Dromius piceus Dej*... McMunn, Man., (Wallis).
1884 *Nothopus zabroides* Lec. Medicine Hat, Alta., (Carr).
1941 *Harpalus cautus* Dej. Medicine Hat, Alta., (Carr).
1944 *Harpalus pleuriticus* Kby. Medicine Hat, Alta., (Carr).
1979 *Harpalus funestus* Lec. Medicine Hat, Alta., (Carr).
1984 *Harpalus fraternus* Lec. Medicine Hat, Alta., (Carr).
Harpalus basilaris Kby. Edmonton, Alta., (Carr).
Harpalus ochropus Kby. Medicine Hat, Alta., (Carr).
2039 *Selenophorus pediculatus* Dej. Medicine Hat, Alta., (Carr).
2087 *Anisodactylus harrisi* Lec. Medicine Hat, Alta., (Carr).
2173 *Stenocellus debilipes* Say. Medicine Hat, Alta., (Carr).
2183 *Stenocellus lustrellus* Csy. Medicine Hat, Alta., (Carr).

Amphizoidae

2281 *Amphizoa lecontei* Matth. Kootenai River, B. C.

Omophronidae
19166 *Prosecon decoloratum* Fall. Medicine Hat, Alta., (Carr).

Haliplidae
2297 *Brychius hornii* Cr. Koksilah River, V. I., B. C., (Carr).
2300 *Haliplus connexus* Math. Ludlow, N. B., (Brown).
2305 *Haliplus cribrarius* Lec. Ludlow, N. B., (Brown).
2310 *Haliplus vancouverensis* Math. Jasper, Alta.
2317 *Haliplus borealis* Lec. Sackville, N. B., (Brown).

Dytiscidae
2354 *Laccophilus inconspicuus* Fall. Aylmer, Que., (Brown).
2389a *Bidessus affinis erythrostomus* Mann. B.C., (Keen).
2390 *Bidessus affinis* Say. Fredericton, N. B., (Brown).
2395 *Bidessus fuscatus* Cr. Covey Hill, Que., (Brown).
2403 *Coelambus punctatus* Say. French Lake, N. B., (Brown); Covey Hill and Kazubazua, Que., (Brown).
2413 *Coelambus suturalis* Lec. Minaki, Ont., (McDunnough).
2424 *Coelambus impressopunctatus* Sch. Saskville, N.B., (Brown).
2425 *Coelambus laccophilinus* Lec. Brome Lake, Que., (Brown); Ottawa, Ont., (Beaulne).
19189 *Coelambus falli* Wallis. Kazubazua, Que., (Brown).
Coelambus dentiger Fall. Roche Percee, Sask., (S. Criddle).
2430 *Hydroporus griseostriatus* De G. Covey Hill, Que., (Brown).
2442 *Hydroporus shermani* Fall. Ventnor, Ont., (Adams).
2247 *Hydroporus undulatus* Say. Sackville, N.B., (Brown).
2452 *Hydroporus clypealis* Shp. Kazubazua, Que., (Brown).
2460 *Hydroporus sulcipennis* Fall. South Bolton, Que., (Adams).
2464 *Hydroporus carolinus* Fall. Fredericton, N. B.,(Brown).
2467 *Hydroporus solitarius* Shp. Minaki, Ont., (McDunnough).
2506 *Hydroporus dentellus* Fall. Knowlton, Que., (Brown).
2508 *Hydroporus signatus* Mann. Covey Hill, Que., (Brown).
2510 *Hydroporus dichrous* Melsh. Ventnor, Ont., (Adams).
2511 *Hydroporus melsheimeri* Fall. Fairy Lake, Que., (Brown).
19205 *Hydroporus melanocephalus* Gyll. Kazubazua, Que., (Brown).
19206 *Hydroporus badiellus* Fall. Fredericton, N. B., (Brown).
19215 *Hydroporus columbianus* Fall. French Lake, N. B., (Brown); Ottawa, Ont., (Twinn).
Hydroporus obesus angustior Hatch. Yukon Crossing, Y. T. Bull. Brook. Ent. Soc., XXIII, 221.
Hydroporus striola Gyll. French Lake, N. B., (Brown).
2532 *Agaporus conoideus* Lec. Covey Hill, Que., (Brown).
2539 *Agabus seriatus* Say. Penobsquis, N. B., (Frost).
2551 *Agabus punctulatus* Aube. Covey Hill, Que., (Brown).
2575 *Agabus anthracinus* Mann. Covey Hill and Kazubazua, Que., (Brown).
2580 *Agabus gagates* Aube. Knowlton, Que., (Brown); Penobsquis, N. B., (Brown).
19233 *Agabus oblongulus* Fall., B. C.
19242 *Agabus ambiguus* Say. Kazubazua, Que., (Brown).
2587 *Ilybiosoma bifarius* Kby. Covey Hill, Que., (Brown).
2589 *Ilybius subaeneus* Er. Roche Percee, Sask., (E. and S. Criddle).
2590 *Ilybius pleuriticus* Lec. Kazubazua, Que., (Brown); Fredericton, N. B., (Brown).
2594 *Ilybius ignarus* Lec. Covey Hill, Que., (Brown).
2598 *Ilybius biguttulus* Germ. Knowlton, Que., (Brown); Penobsquis, N.B., (Frost).
2616 *Rhantus binotatus* Harr. Knowlton, Que., (Brown).
Rhantus binotatus immaculatus Hatch. Kodiak, Alaska. Bull. Brook. Ent. Soc., XXIII, 223.
2624 *Rhantus tostus* Lec. Covey Hill, Que., (Brown).

Hydrophilidae
2873 *Cercyon unipunctatus* L. Missisquoi Bay, Que., (Brown).
2876 *Cercyon praetextatus* Say. Missisquoi Bay, Que., (Brown).
2877 *Cercyon marinus* Thoms. Aweme, Man., (Criddle); Saskatoon, Sask., (King).
2880 *Cercyon indistinctus* Horn. Kazubazua, Que., (Brown).
2885 *Cercyon pygmaeus* Illig. Covey Hill and Kazubazua, Que., (Brown); Saskatoon, Sask., (King).
2892 *Cercyon navicularis* Zimm. Kazubazua, Que., (Brown).
2983 *Cercyon haemorrhoidalis* Fab. Covey Hill and Kazubazua, Que., (Brown).
19285 *Cercyon opacellus* Fall. Ottawa, Ont., (Harrington).
Cercyon terminatus Marsh. Covey Hill and Kazubazua, Que., (Brown).

Silphidae
Nicrophorus hybridus Ang. H. Medicine Hat, Alta., (Carr).

Nicrophorus hybridus minnesotianus Hatch. Rosebank, Man.
2991 *Hydnobius substriatus* Lec. Hemmingford, Que., (Armstrong); Ottawa, Ont., (Harrington); Edmonton, Alta., (Carr).
3007 *Anisotoma collaris* Lec. Banff, Alta., (Carr).
3008 *Anisotoma strigata* Lec. Ont.
3009 *Anisotoma obsoleta* Mels. Aweme, Man., (Criddle).
3023 *Leiodes discolor* Mels. Knowlton, Que., (Fisk).
3024 *Leiodes blanchardi* Horn. Knowlton, Que., (Fisk).
3025 *Leiodes obsoleta* Horn. Buctouche, N. B., (Brown); Knowlton, Que., (Fisk).
3027 *Leiodes geminata* Horn. Ottawa, Ont., (Harrington).
3029 *Agathidium oniscoides* Beauv. Knowlton, Que., (Brown).
3030 *Agathidium exiguum* Mels. Fredericton, N. B., (Brown); Knowlton, Que., (Brown).

Staphylinidae
3464 *Geodromicus plagiatus* Fab. Aweme, Man., (Wallis).
4326 *Staphylinus badipes* Lec. Medicine Hat, Alta., (Carr).
4632 *Oxyporus rufipennis* Lec. Knowlton, Que., (Brown).
4635 *Oxyporus fasciatus* Mels. Val Morin, Que.
4640 *Oxyporus quinquemaculatus* Lec. Knowlton, Que., (Brown).
4652 *Tachinus memnonius* Grav. Victoria Beach, Man.

Scaphidiidae
6515 *Baeocera concolor* Fab. Gatineau Point, Que., (Brown); Ottawa, Ont., (Har-(Harrington); Saskatoon, Sask., (King).

Histeridae
6661 *Cybistrix cylindrica* Payk. Victoria Beach, Man., (Wallis).
6723 *Paromalus aequalis* Say. Medicine Hat, Alta., (Carr).
6866a *Saprinus lubricus plenus* Lec. Medicine Hat, Alta., (Carr).

Cantharidae
7067 *Podabrus protensus* Lec. Niagara Glen, Ont., (Walley).
7072 *Podabrus punctatus* Lec. Kentville, N.S., (Gorham); Bathurst, N.B., (Knull).
7074 *Podabrus puncticollis* Kby. Chelsea, Que.
7081 *Podabrus extremus* Lec. Banff, Alta., (Garrett); Hedley and Mt. McLaine, B.C., (Garrett and Buckell).
7089 *Podabrus cavicollis* Lec. Victoria and Agassiz, B. C., (Downes and Glendenning).
Podabrus conspiratus Fall. Saanich District, Victoria, Agassiz, B.C., (Downes).
Podabrus excursus Fall. Waterton, Alta., (Seamans); Banff, Alta., (Garrett); Vernon and Midday Valley, B. C., (Hopping).
Ent. Americana, VIII, 91.
Podabrus fissilis Fall. Hedley, B. C., (Garrett).
Podabrus heteronychus Fall. Mile 214, Hud. Bay R. R., Man., (Wallis).
Ent. Americana, VIII, 101.
Podabrus obscurevittatus Fall. Edmonton, Alta., (Carr).
Ent. Americana, VIII, 95.
Podabrus pruinosus diversipes Fall. Oliver, Vernon, Vancouver, B.C., (Vroom, Rendell, Chrystal). Waterton, Alta., (Seamans).
7162 *Silis latilobus* Blatch. Aweme, Man., (Criddle).
7215 *Collops vittatus* Say. Edmonton, Alta., (Carr).
7467 *Dasytes hudsonica* Lec. Cypress Hills, Alta., (Carr).

Meloidae
8042½ *Macrobasis debilis* Lec. Roche Percee, Sask., (Wallis).

Pedilidae
8251 *Pedilus lugubris* Say. Winnipeg, Man., (Wallis).
8279 *Macrotria murina* Fab. Kazubazua, Que., (Brown).

Elateridae
8557 *Adelocera brevicornis* Lec. Fredericton, N. B.
8769 *Ludius medianus* Germ. Fredericton, N.B.
8778 *Ludius nigricornis* Panz. Fredericton, N. B.
8850 *Oedostethus femoralis* Lec. Fredericton, N. B.

Buprestidae
Agrilus malvestri Fisher. Medicine Hat and Gray, Alta., (Pursh and Carr).
U. S. N. M. Bull. 145, 247.
Agrilus populi Fisher. Merrit, B. C.
U. S. N. M. Bull. 145, 150.

Dryopidae
9604 *Helichus fastigiatus* Say. Knowlton, P. Q., (Brown).

Heteroceridae
19678 *Heterocerus moleculus* Fall. Medicine Hat, Alta., (Carr).

Dascillidae
9658 *Macropogon rufipes* Horn. Covey Hill, Que., (Brown).
9674b *Ectopria nervosa thoracica* Zieg. Covey Hill and Knowlton, Que., (Brown).
9681 *Eucinetus morio* Lec. Castlereigh, N. S., (Frost).

Helodidae
9686 *Helodes maculicollis* Horn. Kazubazua and Covey Hill, Que., (Brown).
9690 *Microcara explanata* Lec. Aweme, Man., (White).
9693 *Cyphon brevicollis* Lec. Victoria and Shawnigan, B. C., (Downes).
9696 *Cyphon obscurus* Guer. Annapolis Royal, N. S., (Brown); Fredericton, N. B., (Brown); Kazubazua, Que., (Brown).
9697 *Cyphon collaris* Guer. Penobsquis, N. B., (Frost); Covey Hill, P. Q., (Brown).
9699 *Cyphon padi* L. Covey Hill, Que., (Brown).
9704 *Prioncyphon limbatus* Lec. Knowlton, Que., (Brown); Algonquin Park, Ont., (McDunnough).

Dermestidae
9718 *Byturus unicolor* Say. Vancouver, B. C., (Downes).
9728 *Dermestes tristis* Fall. Victoria, B. C., (Downes).
9739 *Dermestes pulcher* Lec. Strathroy, Ont., (Hudson).

Byrrhidae
9862 *Simplocaria tessellata* Lec. Banff, Alta., (Carr).

Nitidulidae
10023 *Meligethes saevus* Lec. Lethbridge, Alta., (Gray).
10039 *Carpophilus pallipennis* Say. Lethbridge, Alta., (Revell).

Cryptophagidae
10384 *Cryptophagus acutangulus* Gyll. Lethbridge, Alta., (Strickland).

Coccinellidae
11011a *Scymnus fraternus* Lec. Medicine Hat, Alta., (Carr).
11015 *Scymnus rubricauda* Csy. Medicine Hat, Alta., (Carr).
11018 *Scymnus cervicalis* Muls. Medicine Hat, Alta., (Carr).
11021 *Scymnus consobrina* Lec. Medicine Hat, Alta., (Carr).
11033 *Scymnus fastigiatus* Muls. Medicine Hat, Alta., (Carr).
11067 *Scymnus tenuivestris* Csy. Medicine Hat, Alta., (Carr).
11082 *Scymnus americana* Muls. Medicine Hat, Alta., (Carr).
11164a *Hippodamia lunato-maculata apicalis* Csy. Medicine Hat, Alta., (Carr).

Alleculidae
11320 *Capnochroa fuliginosa* Mels. Fredericton, N. B., (Simpson).

Tenebrionidae
11872 *Asidopsis polita.* Say. Hanna, Alta., (King).
11933 *Eleodes tricostata* Say. Saskatoon, Sask., (King).
11936 *Eleodes extricata* Say. Morrin, Alta., (Revell).
11949½ *Eleodes opaca* Say. Lethbridge, Alta., (Gray).

Melandryidae
12557 *Xylita laevigata* Hellw. Edmonton, Alta., (Carr).
12569 *Mystaxus simulator* Newn. Fredericton, N. B., (Gorham).
12577 *Symphora flavicollis* Hald. Aweme, Man., (Criddle).

Anobiidae
12709 *Hadrobregmus umbrosus* Fall. Winnipeg, Man., (Wallis).

Cerambycidae
Typocerus manitobensis Sw. & Hopp. Victoria Beach, Man., (Wallis). Nat. Mus. of Can., Bull. 52, 35.
Callidium hardyi Van Dyke, Garden Head, B. C., (Hardy). Pan-Pac. Ent., IV, 112.

Chrysomelidae
15223 *Syneta ferruginea* Germ. Fredericton, N. B., (Simpson).
15282 *Babia quadriguttata* Oliv. Toronto, Ont., (Oakley).
15680 *Calligrapha sigmoidea* Lec. Medicine Hat, Alta., (Carr).
Calligrapha alni Schaef. Westchester Lake, N. S., (Frost); Peterborough, Ont. Jour. N. Y. Ent. Soc., XXXVI, 290.
Calligrapha amelia confluens Schaef. Portaupique, N. S., (Frost). Jour. N. Y. Ent. Soc., XXXVI, 290.
Calligrapha amelia confluens Schaef. Portaupique, N. S., (Frost). Jour. N. Y. Ent. Soc., XXXVI, 290.
Phaedon carri Hatch. Edmonton, Alta., (Carr). Pan-Pac. Ent., V, 46.
Phaedon vancouverensis Hatch. Nanaimo, B. C., (Van Duzee). Pan-Pac. Ent., V, 62.
20228 *Longitarsus suspectus* Blatch. Trenton, Ont., (Evans).
20236 *Longitarsus aeneola* Blatch. Ottawa, Ont., (Beaulieu).

Hydrothossa boreella Schaef. Husavick, Man., (Roberts); Edmonton, Wostock and Cypress Hills, Alta., (Carr); Midday Creek, B. C., (Hopping).
Jour. N. Y. Ent. Soc., XXXVI, 289.

Curculionidae

16597 *Minyomerus innocuus* Horn. Medicine Hat, Alta., (Carr).
16671 *Barynotus schoenherri* Zett. Fredericton, N. B., (Simpson).
Lepyrus nordenskioedi cinereus Van D. Rampart and Ft. Yukon, Alaska; Dawson and Forty Mile, Y. T., (Blasse).
Pan-Pac. Ent., V, 57.
16803 *Hyperodes indistinctus* Dietz. Medicine Hat, Alta., (Carr).
16879 *Hypomolyx piceus* DeG. Fredericton, N. B., (Simpson).
16922 *Notaris puncticollis* Lec. Fredericton, N. B., (Sharpe).
Lixus oregonus tessclatus Van D. Banff, Alta., (Bryant).
Pan-Pac. Ent., V, 56.
Lixus blakeae Chitt. Medicine Hat, Alta., (Carr).
Proc. Ent. Soc. Wash., XXX, 90.
17713 *Cylindrocopturus adspersus* Lec. Medicine Hat, Alta., (Carr).
17782 *Ceutorhynchus dicipiens* Lec. Aweme, Man., (Criddle).

The following lists of Gyrinidae and Scarabaeidae, are based on material in the Canadian National Collection supplemented by the more authentic records from the literature. In the cases of species of general distribution, all known localities have not been included. The lists are arranged in accordance with Leng's Catalogue of Coleoptera except in the case of the genus *Gyrinus*, where the arrangement is that of Mr. Fall's revision of the group.

Gyrinidae of Canada

Dineutes

2674 *discolor* Aube. Que.: Covey Hill, Ft. Coulonge, St. Chrysostome. Ont.: Arnprior, Ottawa.
2679 *nigrior* Rbts. Que.: Covey Hill, Fairy Lake, Kazubazua. Ont.: Pelee Island.
2680 *americanus* Say. Que.: Covey Hill, Fairy Lake, Kazubazua. Ont.: Britannia, Black Rapids. Man.: Treesbank. B.C.: exact locality unknown.
2681 *horni* Rbts. N.S.: Annapolis Royal. Que.: Covey Hill, Fairy Lake, Kazubazua, Knowlton. Ont: Black Rapids.

Gyrinus

2684 *minutus* Fab. Que.: Fairy Lake, Kazubazua. Ont.: Britannia. Man.: Ashdown, Aweme, Kettle Rapids, Le Pas, Mile 256 Hudson Bay Railway, Treesbank. Alta.: Edmonton. B.C.: Barkerville. Alaska: Homer.
2691 *ventralis* Kby. N.B.: Fredericton. Que.: Brome Lake, Fairy Lake, Knowlton's Landing. Ont.: Black Rapids, Britannia, Ingolf.
2686 *fraternus* Coup. Que.: Quebec City.
2687 *aeneolus* Lec. N.B.: Fredericton. Que.: Covey Hill, Montreal, Trousers Lake, St. Chrysostome. Ont.: Black Rapids, Ottawa. Man.: Whitemouth River.
marginellus Fall. N.B.: Fredericon. Que.: Fairy Lake.
2689 *dichrous* Lec. Que.: Brome Lake, Kazubazua, Knowlton's Landing. Ont.: Black Rapids, Ottawa, Ingolf.
latilimbus Fall. Que.: Fairy Lake, Ft. Coulonge, Kazubazua, Knowlton's Landing, St. Chrysostome. Ont.: Britannia, Mer Bleue, Searchmont, Southampton. B. C.: exact locality unknown.
bifarius Fall. N.B.: Fredericton. Que.: Fairy Lake, Ft. Coulonge, Gatineau Point, St. Dennis. Ont.: Britannia. Man.: Kettle Rapids, Mile 332 Hudson Bay Railway, Le Pas. B.C.: Vernon.
2685 *confinis* Lec. N.B.: Fredericton. Que.: Abitibi Region, Brome Lake, Ft. Coulonge, Hull, St. Jean. Ont.: Britannia, Nipigon, Ottawa, Man.: Husavick, Kettle Rapids, Le Pas, Piquitenay River, Selkirk, Treesbank, Winnipeg. B. C.: Douglas Lake, Vernon.
2693 *plicifer* Lec. B.C.: Cowichan River of Vancouver Island.
2694 *consobrinus* Lec. B.C.: Vernon.
2692 *aquiris* Lec. N.B.: French Lake, Sackville. Que.: Fairy Lake, Knowlton's Landing. Ont.: Arnprior, Britannia, Ottawa. Man.: Husavick.
lecontei Fall. Que.: Arnprior, Britannia, Ottawa. Man.: Husavick.
Rapids, Britannia, Mer Bleue, Toronto.
2695 *maculiventris* Lec. Que.: Fairy Lake. Man.: Aweme, Ashdown, Husavick, Le Pas, Mile 256 Hudson Bay Railway, Minnedosa, Piquitenay River, St. Norbert, Treesbank, Winnipeg. Alta: Edmonton. B. C.: Revelstoke Mt.
pleuralis Fall. Alta.: Lethbridge, Medicine Hat, Pincher.
2696 *affinis* Aube. N.B.: Boiestown, Fredericton. Que.: Covey Hill, Hull, Kazubazua, Wakefield. Ont.: Ottawa, Southampton. Man.: Aweme. Alta.: Edmonton. B. C.: McBride, Okanagan Lake, Pender Harbor, Vernon.

2703 *pectoralis* Lec. Que.: Covey Hill, Kazubazua, Lake Abitibi. Man.: Ashdown, Aweme, Mile 256 Hudson Bay Railway, Onah, Piquitenay River, Winnipeg. Alta.: Edmonton.
pugionis Fall. N.S.: Uniacke. Que.: Fairy Lake, Kazubazua. Ont.: Arran Lake, Arnprior.
2704 *picipes* Aube. Man.: Mile 256 Hudson Bay Railway. Alta.: Banff. B.C.: Agassiz, Cawston, McBride, Vernon. Alaska: Sitka, Homer.
2607a *lugens* Lec. Nfld.: Little River. N.S.: Uniacke. N.B.: Boiestown, Fredericton. Que.: Covey Hill, Hull, Knowlton, Kazubazua, St. Chrysostome. Ont.: Britannia, Black Rapids, Ottawa. Man: Kettle Rapids, Piquitenay River, Mile 214 and 332 Hudson Bay Railway.
2700 *analis* Say. N.S.: Kempf Shore. Ont.: exact locality unknown. Man.: Onah.
opacus Sahl. Labr.: West St. Modest. Que.: East Coast of James Bay. Ont.: Cochrane. Man.: Kettle Rapids, Mile 332 Hudson Bay Railway. Alta.: Edmonton. Alaska: Peninsula district.
wallisi Fall. Ont.: exact locality unknown. Man.: Le Pas, Mile 214 and 256 Hudson Bay Railway, Piquitenay River. Alta.: Edmonton, Ponoha.
frosti Fall. Que.: Kazubazua.
2706 *impressicollis* Kby. Que.: Kazubazua. Ont.: Thunder Bay. Man.: Piquitenay River.
2697 *piceolus* Blatch. Que.: Fairy Lake.
dubius Wallis. Nfld.: St. Anthony.

Scarabaeidae of Canada

Canthon
13041 *praticola* Lec. Man.: Melita, Lyleton. Sask.: Estevan, Palmer, Mortlach. Alta.: Lethbridge, Medicine Hat.
13045a *simplex corvinus* Har. Alta.: Cypress Hills, Medicine Hat. B.C.: Cranbrook, Creston, Rock Creek, Victoria.
13047 *vigilans* Lec. Ont: exact localiy unknown.
13048 *laevis* Dru. Alta.: Medicine Hat.
13050 *chalcites* Hald. Ont.: exact locality unknown.
13053 *perplexus* Lec. Alta.: Macleod.

Copris
13065 *tullius* Oliv. Que.: Joliette Co. Ont.: Pelee Island, Preson, Trenton.

Onthophagus
13080 *hecate* Panz. N.S.: Annapolis Royal, Middleton. N.B.: St. John, Fredericton, Boiestown. Que.: Aylmer, Covey Hill, Montreal, Knowlton, Kazubazua. Ont.: Ottawa. Man.: Aweme, Marchand, Lyleton, Onah. Sask.: Roche Percee. Alta.: Medicine Hat.
13082 *orpheus* Panz. Ont.: exact locality unknown. Man.: Aweme, Onah, Treesbank,
13086 *pennsylvanicus* Har. Que.: St. Johns Co. Ont.: exact locality unknown.
13088 *nuchicornis* L. N.S.: Annapolis Royal, Kentville. N.B.: Boiestown, Fredericton, Sackville. Que.: Covey Hill, Fairy Lake, Knowlton, Kazubazua. Ont.: Black Rapids, Ottawa.

Aegialia
13097 *rufescens* Horn. Ont.: Hastings Co.
13098 *cylindrica* Esch. B.C.: Queen Charlotte Islands. Alaska: Unalaska, Skagway.
13099 *lacustris* Lec. Que.: Kazubazua, Montreal. Ont.: Ottawa. Man.: Aweme, Husavick, Stonewall, Winnipeg. Alta.: Kannanaskis, Beaver Creek, Edmonton. B. C.: Midday Valley, Terrace.
13100 *blanchardi* Horn. B.C.: Mission, Vancouver.
13101 *pusilla* Horn. Man.: Aweme, Birtle. B.C.: Cawston.
13102 *conferta* Horn. Ont.: Prince Edward Co.
13104 *opifex* Horn. Que.: Kazubazua.
crassa insularis Brown. B.C.: Queen Charlotte Islands.

Aphodius
13107 *fossor* L. N.B.: Fredericton, St. Andrews. Que.: Covey Hill, Fairy Lake, Ft. Coulonge, Knowlton, Kazubazua. Ont.: Guelph, Picton, Ottawa.
13108 *validus* Horn. Que.: Montreal. Man.: Aweme, Hudson's Bay, Stonewall. Sask.: Saskatoon. Alta.: Lethbridge, Edmonton.
13109 *hamatus* Auct. Que.: Covey Hill, Ft. Coulonge, Kazubazua. Man.: Aweme, Glen Souris, Onah. Sask.: Roche Percee, Ogema. Alta.: Bilby, High River, Leduc. B. C.: Ft. St. John, Pouce Coupe, Midday Creek.
13109a *hamatus occidentalis* Horn. Que.: Montreal. Man.: Aweme, Pierson. Sask.: Hague. Alta.: Banff, Bilby, Turner Valley, Waterton.
13110 *erraticus* L. N.S.: Port Medway. N.B.: Sackville. Que.: Aymler, Covey Hill, Knowlton, Kazubazua. Ont.: Picton, Ottawa.
13111 *haemorrhoidalis* L. N.B.: Boiestown. Que.: Knowlton, Fairy Lake.

13112 *denticulatus* Hald. Alta.: Medicine Hat.
13118 *bidentatus* Schm. B.C.: Bear Flats.
13119 *fimetarius* L. N.S.: Annapolis Royal, Kentville. N.B.: Boistown, Fredericton, Sackville. Que.: Covey Hill, Fairy Lake, Knowlton, Kazubazua. Ont.: Guelph, Ottawa, Ingolf. Man.: Aweme, Bird's Hill, Winnipeg. Sask.: Roche Percee. Alta.: Lethbridge, Slave Lake, Edmonton, Medicine Hat. B.C.: Salmon Arm, Vernon, Peachland, Cawston, Revelstoke Mountain.
13120 *sigmoideus* Van D. B.C.: Skagit River.
13121 *congregatus* Mann. Alta.: Banff, Ptarmigan Pass, Edmonton. B.C.: Mt. McLean, Revelstoke. Alaska.
13122 *aleutus* Esch. B.C.: Copper Mountain, Victoria.
13123 *putridus* Hbst. Ont.: Sudbury. Man.: Aweme, Winnipeg. Alta.: Bilby, Banff, Edmonton, Morley. B. C.: Cranbook.
13124 *duplex* Lec. Man.: Aweme. Sask.: Saskatoon. Alta.: Morley, Edmonton.
13126 *pectoralis* Lec. B.C.: Vancouver Island, Queen Charlotte Islands. Alaska: Eagle, Dawson, White Horse.
13127 *ruricola* Mels. N.S.: Annapolis Royal, Halifax. N.B.: Boiestown, Fredericton, Saskville. Que.: Covey Hill, Montreal, Kazubazua. Ont.: Black Rapids, Trenton, Ottawa. Man.: Aweme, Onah, Miami, Bird's Hill, Baldur, Treesbank. Sask.: Saskatoon. Alta.: Medicine Hat.
13129 *anthracinus* Lec. Alta.: Banff.
13131 *granarius* L. N.S.: Annapolis Royal, Halifax, Kentville. N.B.: Boiestown, Bathurst, Fredericton, Saskville. Que.: Covey Hill, Knowlton, Montral, Kazubazua, Fairy Lake. Ont.: Ottawa, Picton. Alta.: Medicine Hat. B. C.: Revelstoke Mountain, Agassiz.
13132 *vittatus* Say. N.S.: Annapolis Royal. N.B.: Fredericton. Que.: Covey Hill, Knowlton, Kazubazua, Montreal. Ont.: Picton, Ottawa. Man.: Aweme, Stonewall. Sask.: Roche Percee. Alta.: Calgary, St. Mary River, Morley, Banff, Tofield. B. C.: Chilcotin, Mard, Midday Valley, Oliver, Peachland.
13133 *guttatus* Esch. Alaska: Amak Island.
13140 *alternatus* Horn. Man.: Aweme, Lake Dauphin, Onah. Sask.: Saskatoon, Alta.: Cypress Hills, Medicine Hat, Olds.
13146 *opacus* Lec. Alta.: Moraine. B.C.: Cranbrook, Midday Valley, Vancouver Island.
13149 *lentus* Horn. Que.: Chambly Co., Knowlton, Terrebonne Co.
13151 *explanatus* Lec. Man.: Aweme. Sask.: Moose Jaw. Alta.: Cowley, Banff, Calgary, Medicine Hat, Olds. B. C.: Nelson.
phaeopterus canadensis Garn. Alta.: Waterton. B. C.: Chase, Cranbrook, Crow's Nest.
13155 *brevicollis* Lec.: Man.: Aweme, Darlingford.
13159 *rubeolus* Beauv. Que.: Rouville Co.
13160 *iowensis* Wickh. Man.: Aweme, Onah.
13162 *stercorosus* M ls. Que.: Chambly Co., Joliette Co.
13170 *consentaneus* Lec. Man.: Aweme, Onah. Sask.: Moose Jaw, Oxbow, Roche Percee. Alta.: Kannanaskis.
13179 *coloradensis* Horn. Alta.: Medicine Hat.
13180 *bicolor* Say. Que.: Hull. Ont.: exact locality unknown.
13184 *distinctus* Mull. N.S.: Annapolis Royal. N.B.: Boistown, Fredericton, Sackville. Que.: Aylmer, Covey Hill, Knowlton, Kazubazua, Montreal. Ont.: McClure, Ottawa, Trenton. Man.: Aweme, Miami, Onah, Holland, Rosebank. Sask.: Saskatoon, Roche Percee. Alta.: Medicine Hat, Cypress Hills. B. C.: Cranbrook, Revelstoke Mountain, Vernon.
13185 *pardalis* Lec. B.C.: Powell River, Royal Oak.
13186 *leopardus* Horn. Que.: Aylmer, Kazubazua. Ont.: Ottawa, Treton. Man.: Aweme, Husavick, Rosebank. Alta.: Banff, Edmonton.
13194 *scabriceps* Lec. Alta.: Medicine Hat.
peculiosus awemeanus Brown. Man.: Aweme, Stony Mountain.
13198 *rubripennis* Horn. Que.: Kazubazua, Knowlton.
13200 *walshii* Horn. Man.: Aweme, Onah, Bird's Hill.
13202 *prodromus* Brahm. N.B.: Miscou Harbor. Que.: Fairy Lake. Ont.: Bancroft. Ottawa, Trenton.
13204 *oblongus* Say. Ont.: Ottawa.
13207 *tragicus* Schm. Ont.: Chatham.
edmontonus Brown. Alta.: Edmonton.
manitobensis Brown. Man.: Aweme.
bryanti Brown. Alta.: Calgary.
leptotarsis Brown. "N. W. T."
aquilonarius Brown. Sask.: Saskatoon. Alta.: Calgary, Medicine Hat.
thomomysi Brown. Man.: Aweme.
criddlei Brown. Man.: Aweme, Rosebank. Sask.: Redvers. Alta.: Edmonton.

talpoidesi Brown. Man.: Aweme.
socialis Brown. Man.: Aweme.
carri Brown. Alta.: New Dayton, Medicine Hat.
albertanus Brown. Alta.: Banff, Calgary, Kannanaskis.

Oxyomus
13210 *silvertris* Scop. N.S.: Halifax (in cargo from Europe).

Ataenius
13226 *gracilis* Mels. Ont.: Trenton.
13233 *cognatus* Auct. Que.: Covey Hill, Montreal. Ont.: Point Pelee, Ottawa, Trenton.

Dialytes
13237 *truncatus* Mels. Ont.: exact locality unknown.
13238 *ulkei* Horn. Ont.: exact locality unknown.
13239 *striaulus* Say. Que.: Kazubazua, Montreal. Ont.: Black Rapids.

Rhyssemus
13253 *sonatus* Lec. Sask.: Roche Percee.
puncticollis Brown. Ont.: Toronto.

Ochodaeus
13263 *musculus* Say. Man.: Winnipeg (doubtful record).

Odontaeus
13287 *obesus* Lec. B.C.: Salmon Arm, Vernon, Keremeos, Vancouver Island.
falli Wallis. Que.: Quinze Lake. Ont.: Ottawa. Man.: Aweme, Winnipeg. Sask.: Regina, Roche Percee.
liebecki Wallis. Que.: Hemmingford, Knowlton, Senneville. Ont.: exact locality unknown.

Bolbocerosoma
bruneri Daw. & McC. Man.: Woburn (doubtful record).

Eucanthus
13259 *lazarus* Fab. Man.: Aweme, Onah.

Geotrupes
13290 *balyi* Jek. N.S.: Port Medway. Que.: Ft. Coulonge, Kingsmere. Ont.: Cobalt, Ottawa. Man.: Victoria Beach.
13298 *semiopacus* Jek. Que.: M ach Lake. Ont.: Lyn, Marmora, Ottawa. Man.: Bird's Hill, Deloraine, Rounthwaite, Victoria Beach.
13299 *splendidus* Fab. N.S.: Annapolis Royal. Que.: Ft. Coulonge, Kazubazua. Ont.: Sudbury Co.

Amphicoma
13317 *canina* Horn. B.C.: Agassiz.

Glaresis
canadensis Brown. Man.: Aweme.

Trox
13331 *suberosus* Fab. Ont.: exact locality unknown.
13333 *tuberculatus* De G. Man.: Aweme, Bird's Hill. Alta.: Medicine Hat.
13337 *capillaris* Say. Ont.: exact locality unknown.
13338 *unistriatus* B auv. Que.: Ft. Coulonge. Ont.: Preston. Man.: Aweme. Sask.: Roche Percee. Alta.: Lethbridge, Medicine Hat.
13339 *sordidus* Lec. N.S.: Shelburne. Ont.: Trenton.
13342 *aequalis* Say. Ont.: Otawa. Man.: Aweme.
13343 *scaber* L. Ont.: Trenton. Man.: Aweme, Miami, Treesbank.
13345 *atrox* Lec. Man.: Aweme. Sask.: Roche Percee. Alta.: Medicine Hat, Lethbridge.

Serica
13357 *intermixta* Blatch. Que.: Montreal. Ont.: Ottawa, Trenton. Man.: Aweme. Alta.: Edmonton.
13363 *tristis* Lec. Magdalen Islands. N.S.: Aylesford, Derbert, Kentville, Middleton, Round Hill, Truro. N. B.: Chaleur Bay, St. Andrews, St. Stephens. Que.: Ft. Coulonge, Seven Islands, Three Rivers. Ont.: Hymers, Nipigon, Ottawa. Man.: Aweme, Onah, Stonewall, Winnipeg.
13364 *sericea* Ill. Que.: Ft. Coulonge, Lanoraie, Montreal, Three Rivers. Ont.: Ottawa, Point Pelee, Toronto, Trenton. Man.: Aweme, Baldur, Onah, Thornhill, Winnipeg. B. C.: Cawston, Vernon.
13365 *curvata* Lec. Que.: Lanoraie. Man.: Aweme, Onah. B.C.: Buccaneer, Golden Nanaimo, Nelson, Peachland, Salmon Arm.
13369 *anthracina* Lec. B.C.: Gorge, Lillooet, Minnie Lake, Vernon.
cucullata Daw. N.S.: Kentville. Que.: Hemmingford, Montreal, St. Therese Island. Ont.: Ottawa. Man.: Aweme, Winnipeg. B. C.: exact locality unknown.

lecontei Daw. N.S.: exact locality unknown. Que.: Three Rivers. Ont.: Ottawa, Toronto.
parallela Csy. Que.: Three Rivers. Ont.: Jubilee Point.

Diplotaxis
13376 *sordida* Say. Ont.: Trenton.
13377 *rugosioides* Schaef. Ont.: Ottawa.
13394 *residua* Fall. B.C.: Oliver.
13397 *brevicollis* Lec. B.C.: Cranbrook, Creston, Agassiz, Rossland, Salmond Arm, Victoria.
13408 *obscura* Lec. Man.: Aweme. Alta.: Edmonton. B.C.: Nicola, Cawston, Vernon.
13409 *tristis* Kby. N.S.: Kentville, Bridgetown. Que.: Hemmingford. Ont.: Ottawa, Man.: Aweme, Baldur.
13416 *subangulaa* Lec. B.C.: Olicer, Similkameen River.

Phyllophaga
13496 *gracilis* Burm. Rrecorded from "Canada".
13497 *futilis* Lec. Ont.: Windsor, Caradoc.
13506 *inversa* Horn. Ont.: Strathroy.
13511 *fusca* *Froel.* Nfld.: exact locality unknown. N.S.: Kentville. Que.: Knowlton. Ont.: Trenton.
13516 *anxia* Lec. Nfld.: St. Johns. N.S.: Round Hill. N.B.: Fredericton. Que.: Covey Hill, Knowlton, Kazubazua. Man.: Aweme, Treesbank, Winnipeg. Alta.: Banff, Edmonton.
13517 *drakei* Kby. N.S.: Halifax, Round Hill, Sable Island. Que.: Knowlton. Man.: Aweme, Winnipeg. Alta.: Edmonton.
13520 *marginalis* Lec. N.S.: Port Maitland. Ont.: Strathroy.
13520 *fraterna* Harris. Ont.: Trenton.
13530 *rugosa* Mels. Ont.: Trenton. Man.: Aweme, Stockton.
13534 *implicita* Horn. B.C.: Victoria.
13335 *balia* Say. Ont.: Point Pelee.
13337 *nitida* Lec. Man.: Aweme, Winnipeg. Alta.: Edmonton.
13340 *icilis* Knoch. Ont.: Strathroy.
13363 *tristis* Fab. B.C.: Vernon.

Polyphylla
13598 *hammondi* Lec. Man.: Aweme.
13621 *ruficollis* Csy. B.C.: Buccaneer, Duncan, Victoria.
13624 *variolosa* Hentz. Que.: Ft. Coulonge, Norway Bay.

Dichelonyx.
13649 *elongata* Fab. Que.: Aylmer, Knowlton, Ft. Coulonge. Ont.: Jock River, Byron.
13650 *canadensis* Horn. Que.: Ft. Coulonge, Kazubazua. Ont.: Bancroft, Mer Bleue, Ottawa.
13651 *subvittata* Lec. N.S.: Kentville. Que.: Covey Hill, Knowlton, Meach Lake. Ont.: Algonquin, Nipigon, Strathroy. Man.: Aweme, Winnipeg.
13652 *diluta* Fall. N.S.: Kentville, Annapolis Royal.
15654 *testacea* Kby. Man.: Aweme, Onah. Alta.: Lethbridge, Edmonton.
15655 *backi* Kby. Ont.: Bird's Creek. Man.: Aweme. Sask.: Wadena, Saskatoon, Kennedy. Alta.: Cowley, Innisfail, Edmonton. B. C.: Aspen Grove, Cranbrook, Spious Creek, Sicamous.
15657 *fulgida* Lec. B.C.: Seton Lake, Royal Oak, Vernon, Vancouver.
15658 *oregona* Van D. B.C.: Vernon.
15673 *vicina* Fall. B.C.: Aspen Grove, Hedley, Kamloops.
15676 *albicollis* Burm. N.S.: Kentville, Que.: Aylmer, Knowlton, Ont.: Ottawa.

Macrodactylus
13685 *subspinosus* Fab. Ont.: Jordan, Ottawa, Toronto.

Hoplia
13692 *laticollis* Lec. Man.: Aweme, Onah.
13694 *trifasciata* Say. Que.: Ft. Coulonge, Kazubazua. Ont.: Orillia, Ottawa.

Anomala
13709 *binotata* Gyll. Ont.: Guelph.
13731a *nigropicta canadensis* Csy. Ont.: exact locality unknown.

Pachystethus
13741 *lucicola* Fab. Ont.: exact locality unknown.

Strigoderma
13747 *arboricola* Fab. Ont.: Point Pelee.

Pelidnota
13755 *punctata* L. Ont.: Preston, Niagara Falls, St. Thomas.

Cotalpa
13769 *lanigera* L. Ont.: Kincardine, Port Stanley, Preston, Strathroy. Man.: Aweme, Onah.

Pocalta
13780 *rubripennis* Csy. B. C.: Victoria.

Ochrosidia
13801 *immaculata* Oliv. Ont.: exact locality unknown.

Ligyrodes
13834 *relictus* Say. Que.: Aylmer. Ont.: Arnprior, Ottawa, Restrevor.

Ligyrus
13843 *gibbosus* De G. (?) Sask.: Indian Head.

Aphonus
1370 *aterrimus* Csy. Que.: Ft. Coulonge. Ont.: exact locality unknown.

Xyloryctes
13906 *obsolescens* Csy. Ont.: Trenton.

Euphoria
13937 *fulgida* Fab. Ont.: Belleville.
13940 *inda* L. Que.: Covey Hill. Ont.: Lake Huron, Olinda. Alta.: Medicine Hat, Schuler.
13940a *inda nigripennis* Klag. Ont.: Strathroy, Toronto.

Cremastocheilus
13972 *harrisi* Kby. Que.: Charlevoix Co.
13973 *canaliculatus* Kby. Que.: Ft. Coulonge.
13975 *pocularis* Csy. Man.: Aweme.
13978 *incisus* Csy. Alta.: Medicine Hat.
13983 *bifoveatus* Van D. B. C.: Lillooet, Chilcotin, Vernon, Peachland.
13995 *knochi* Lec. Man.: Aweme. Alta.: Medicine Hat.

Trinodia
14008 *wheeleri* Lec. Man.: Aweme. Alta.: Cochrane.

Osmoderma
14009 *delicatula* Csy. Que.: Aylmer.
14012 *eremicola* Knoch. Que.: Montreal. Ont.: Trenton. Man.: Aweme, Treesbank. Alta.: Lethbridge.

Gnorimella
14013 *maculosa* Knoch. Ont.: Ottawa.

Trichiotinus
14022 *assimilis* Kby. Que.: Aylmer, Covey Hill, Knowlton. Ont.: Burk's Falls, Ottawa. Man.: Aweme. Alta.: Edmonton. B. C.: Aspen Grove, Salmon Arm, Seton Lake.

HEMIPTERA

PREPARED BY G. STUART WALLEY

The following list of Scutelleridae, Cydnidae and Pentatomidae is arranged in accordance with the Van Duzee "Catalogue of Hemiptera" except for certain necessary changes in nomenclature. The list aims to include the distribution of the Canadian species of Pentatomoidea based on representatives in the Canadian National Collection supplemented by the more authentic records from the literature, particularly the "Entomological Record" and Downes' "Preliminary List of the Heteroptera and Homoptera of British Columbia," (Proc. B.C. Ent. Soc., No. 23, 1927).

PENTATOMOIDEA

Family SCUTELLERIDAE

Tetyrinae

Homaemus aeneifrons (Say). Cape Breton Isl.: Cheticamp. Madeleins: Grindstone Isl. N.S.: Annapolis Royal, Kentville. N.B.: Greys Mills, Youghall. Que.: Aylmer, Kazubazua, North Hatley, Quinze L., Sherbrooke. Ont.: Chalk R., Muskoka, Sudbury. Man.: Aweme. Sask.: Saskatoon. Alta.: Armena, Athabasca, Nordegg, Waterton. B.C.: Arm-

strong, Chilcotin, Crow's Nest, Goldstream, Lytton, Lucerne Sta., Oliver, Shawinigan, Saanich Dist., Summerland, Vernon. N.W.T.: Ft. Norman McKenzie R.

Homaemus bijugis (Uhl.). Sask.: Regina. B.C.: Arrowhead, Fairview, Goldstream, Midday V., Merritt, Royal Oak.

Odontotarsinae

Eurygaster alternatus (Say). N.B.: Fredericton. Que.: Covey Hill, Kazubazua, L. Temagami, Quinze L. Ont.: Belleville, Muskoka, Ottawa, Strathroy, Sudbury. Man.: Aweme, Onah, Winnipeg. Sask.: Ruby, Saskatoon. Alta.: Clareshome, Cowley, Lethbridge, Nanton, Shaftbury. B.C.: Enderby, Duncan, Penticton, Royal Oak, Saanich, Victoria.

Eurygaster shoshone Kirk. B.C.: Vernon.

Phimodera torpida Wlk. Man.: Aweme, Dauphin. Sask.: (no locality given). B.C.: Chilcotin, Grand Forks, Vernon.

Vanduzeeina balli Van D. B.C.: Chilcotin, Kamloops, Seton L. Lillooet.

Vanduzeeina borealis Van D. B.C.: Emerald L., Golden.

Family CYDNIDAE

Thyrecorinae

Galgupha atra Am. & Serv. N.S.: Annapolis Royal. Que.: Covey Hill, Knowlton, Montreal. Ont.: Miner's Bay, Muskoka, Ottawa, Pt. Pelee, Strathroy, Sudbury, Trenton. Man.: Aweme, Treesbank, Winnipeg. B.C.: Agassiz, Cranbrook, Enderby, Oliver.

Galgupha nigra (Dallas). Ont.: Hudson Bay.

Galgupha nitiduloides (Wolff). N.W.T.: (locality not given).

Corimelaena anthracine Uhl. Man.: Dauphin. Alta.: Nordeg. B.C.: Huntingdon, Merritt, Vancouver Isl.

Corimelaena montana (Van D.). B.C.: Enderby, Midday Val., Merritt, Similkameen R.

Corimelaena extensa Uhl. B.C.: Chilliwack.

Corimelaena pulicaria (Germ.). Que.: St. Hilaire. Ont.: Belleville, Ottawa, Pt. Pelee, Strathroy. Man.: Winnipeg. B.C.: Agassiz, Chilliwack, Enderby, Penticton, Vernon.

Corimelaena lateralis (Fabr.). Ont.: Guelph.

Cydninae

Pangaeus bilineatus (Say). Que.: (locality not given). B.C.: Kaslo, Vernon

Amnestus pusillus Uhl. Que.: St. Hilaire. Ont.: Trenton.

Amnestus spinifrons (Say). Que.: Hull. Ont.: Ottawa.

Sehirus cinctus (P. B.) N.S.: Sydney Mines. N.B.: Canaan. Que.: Coaticook. Ont.: Norway Pt. L. of Bays, Ottawa, Trenton. Man.: Dauphin, Winnipeg. Sask.: Ruby. Alta.: Brooks. B.C.: Vernon.

Family PENTATOMIDAE

Graphosomatinae

Podops cinctipes Say. Que.: Hemmingford, Montreal. Ont.: Belleville, Trenton.

Podops parvulus Van D. Que.: Montreal.

Penatominae

Sciocoris microphthalmus Flor. Ont.: Hymer, Norway Pt. L. of Bays, Sudbury. Sask.: Saskatoon.

Brochymena arborea (Say). Que.: Aylmer. Ont.: Preston.

Brochymena quadripustulata Fabr. Que.: Covey Hill, Lachute. Ont.: Grimsby, Guelph, Perth. B.C.: Penticton, Walhachlin.

Brochymena affnis Van D. B.C.: Kelowna, Peachland, Vernon.

Peribalus abbreviatus (Uhl.). Ont.: Carp. Alta.: Vauxhall. B.C.: Duncan, Oliver, Princeton, Saanich, Seton L. Lillooet, Vernon.

Peribalus limbolarius Stal. Que.: Fairy L. Ont.: Ottawa, Sudbury. Man.: Aweme. Alta.: Lethbridge. B.C.: Arrowhead, Departure Bay, Penticton, Royal Oak, Saanich, Seton L., Lillooet, Summerland, Victoria.

Peribalus tristis Van D. Alta.: Waterton. B.C.: Rochcreek, Vancouver Isl.

Peribalus piceus (Dallas). Que.: Ft. Coulonge. Ont.: Hymer, Nepigon, Sudbury. Man.: Aweme. Sask.: St. Louis.

Trichopepla atricornis Stal. Man.: Carberry. Alta.: Banff, Calgary, Nordegg, Waterton. B.C.: Ft. St. John.

Trichopepla californica Van D. B.C.: Mt. Garibaldi (6,500 ft.).

Trichopepla aurora Van D. B.C.: Merrit, Vernon, Victoria.

Trichopepla semivittata (Say). Que.: Montreal.

Rhytidolomia belfragei Stal. "Canada" (Uhler).
Rhytidolomia viridicata Walk. Alta.: Lethbridge.
Rhytidolomia faceta Say. Man.: Aweme. Sask.: Saskatoon.
Chlorochroa uhleri Stal. N.S.: Annapolis Royal, Kentville. N.B.: St. Stephen. Que.: Hemmingford, Montreal. Ont.: Belleville, Guelph, Jordan, Ottawa, Simcoe, Spencerville, Sudbury. Man.: Aweme. Alta.: Lethbridge, Medicine Hat, Waterton. B.C.: Agassiz, Bear Flats, Creston, Departure Bay, Ft. St. John, Kaslo, Newgate, Oliver, Osoyoos L., Pouce Coupe, Rolla, Royal Oak, Saanich Dist., Terrace, Vernon, Victoria.
Chlorochroa ligata (Say). B.C.: Vancouver Isl., Vernon.
Chlorochroa sayi Stal. B.C.: Vernon.
Carpocoris remotus Horv. Man.: Aweme, Treesbank. Sask.: Lacadena, Saskatoon. Alta.: Coaldale, Lardston, Lethbridge, MacLeod, Magrath, Raymond, Stirling. B.C.: Enderby, Gordon Head, Lillooet, Thormanby Isl., Vernon.
Mormidea lugens (Fabr.). Que.: Aylmer, Chelsea, Ft. Coulonge, Hemmingford, Kazubazua, Kingsmere, Knowlton, Montreal. Ont.: Arnprior, Muskoka, Ottawa, Pt. Pelee, Simcoe, Strathroy, Sudbury. Man.: (no locality given).
Euschistus euschistoides (Voll.). N.S.: Halifax. Que.: Covey Hill, Ft. Coulonge, Hemmingford, Ironsides, Kingsmere, Montreal. Ont.: Guelph, Norway Pt. L. of Bays, Ottawa, Simcoe. Man.: Aweme, Winnipeg. B.C.: Agassiz, Departure Bay, Lillooet, Mission, Vernon, Victoria.
Euschistus conspersus Uhl. B.C.: Departure Bay, Gabriola Isl., Lillooet, Royal Oak, Saanich, Vernon, Victoria.
Euschistus tristigmus (Say). Cape Breton Isl.: Cheticamp. N.S.: Halifax, Smith's Cove. Que.: Aylmer, Deschenes, Fairy L., Ft. Coulonge, Montreal. Ont.: Algonquin Pk., Grimsby, Guelph, Norway Pt. L. of Bays, Simcoe, Sudbury, Trenton. Man.: Husavick, Winnipeg.
Euschistus variolarius (P. B.). Que.: Ironsides. Ont.: Caradoc, Guelph, Hamilton, Ottawa, Preston, Simcoe, Strathroy. B.C.: Enderby, Penticton, Vernon.
Euschistus ictericus (Linn.). Ont.: Belleville, Guelph, Ottawa.
Coenus delius (Say). Que.: Covey Hill, Dorval, Kazubazua, Montreal, St. Jean. Ont.: Deseronto, Guelph, Ottawa, Preston, Trenton. Man.: Aweme, Baldur, Westbourne, Winnipeg. Alta.: Lethbridge. B.C.: Oliver.
Hymenarcys aequalis (Say). Sask.: (no locality given).
Hymenarcys nervosa (Say). Que.: (no locality given).
Aelia americana Dallas. Que.: (no locality given). Man.: Aweme, Dauphin, Wawansea, Winnipeg. Sask.: Saskatoon, St. Louis. Alta.: Cardston, Ft. Vermillion.
Neottiglossa trilineata (Kby.). N.S. (Blatchley). Que.: East Coast James Bay. Man.: (no locality given). Sask.: York to Cumberland House. N.W.T.: Mackenzie R.
Neottiglossa undata (Say). N.B.: Fredericton. Que.: Aylmer, Covey Hill, Hull, Montreal. Ont.: Guelph, Ottawa, L. Simcoe, Pt. Pelee, Strathroy, Sudbury. Man.: Aweme, Winnipeg. Sask.: Saskatoon, Skipton. B.C.: Agassiz, Oliver Saanich Dist., Vancouver, Vernon, Victoria.
Neottiglossa tumidifrons Downes. B.C.: Saanich Dist., Victoria.
Cosmopepla bimaculata (Thom.). N.S.: Kentville, Truro. N.B.: Fredericton. Que.: Aylmer, Chicoutimi, Hull, Knowlton, Meach L., Montreal. Ont.: Arnprior, Chalk R., Guelph, Hymers, Lobo, Mer Bleue, Norway Pt. L. of Bays, Ottawa, Pt. Pelee. Man.: Aweme, Gimli, Westburn, Winnipeg. Sask.: Saskatoon. Alta.: Beaver L., Lethbridge. B.C.: Agassiz, Boswell, Creston, Kaslo, Penticton, Royal Oak, Saanich, Vernon.
Cosmopepla conspicillaris (Dallas). B.C.: Departure Bay, Duncan, Gordon Head, Royal Oak, Saanich, Stanley Pk., Vancouver, Victoria.
Eysacoris integressus Uhl. B.C.: Enderby, Departure Bay, Duncan, Goldstream, Lillooet, Mission, Nelson, Penticton, Royal Oak, Vernon, Victoria.
Menecles incertus (Say). Que.: Quebec. Ont.:Ottawa.
Prionosoma podopioides Uhl. B.C.: Ashcroft, Kamloops, Kelowna, Oliver, Osyoos, Vancouver Isl.
Thyanta custator (Fabr.). Que.: (no locality given). B.C.: Departure Bay, Goldstream, Lillooet, Royal Oak, Saanich Dist., Summerland, Victoria, Vancouver.
Thyanta rugulosa (Say). B.C.: Vancouver.
Thyanta punctiventris (Van D.). Sask.: North Battleford. B.C.: Kamloops.
Acrosternum pennsylvanicum (De Geer). Que.: Montreal.

Acrosternum hilaris (Say). Ont.: Guelph, Grimsby, Jordan, Preston, Pt. Pelee, Rondeau, Strathroy, Trenton.
Banasa dimidiata (Say). Que.: Aylmer, Deschenes, Hemmingford, Montreal. Ont.: Mer Bleue, Norway Pt. L. of Bays, Orillia, Ottawa, Preston, St. Ola. Man.: Aweme, Teulon. Sask.: Ft. Qu'Apelle, Saskatoon, Alta.: Lethbridge, Waterton. B.C.: Agassiz, Departure Bay, Saanich, Seton L., Lillooet, Sugar L., Terrace, Vernon, Victoria.
Banasa calva (Say). Ont.: Hastings Co., Jordan, Trenton.
Banasa sordida (Uhl.). Ont.: Preston, Trenton. B.C.: New Westminster, Savary Isl.

Acanthosominae
Meadorus lateralis (Say). N.S.: Annapolis Royal, Halifax, Kedjie. N.B.: Grand Manan. Que.: Aylmer, Covey Hill, Kazubazua, Kingsmere, Knowlton, Montreal. Ont.: Belleville, Guelph, Hastings Co., Normandale, Norway Pt. L. of Bays, Ottawa, Sudbury. Man.: Aweme, Onah. Sask.: (no locality given). Alta.: L. Slave L. B.C.: Agassiz, Goldstream, Royal Oak, Vernon, Victoria.
Elasmostethus cruciatus (Say). Labrador: Manicougan R. N.S.: Barrington Passage, Grand Manan, Halifax, Parker's Cove, Smith's Cove, Weymouth. Que.: Abitibi Region. Ont.: Belleville, Guelph, Hillier, Norway Pt. L. of Bays, Ottawa, Sudbury. Man.: Aweme. Alta.: Shaftsbury. B.C.: Departure Bay, Mt. Cheam, Terrace, Victoria. Yukon Terr.: Klondike Valley.
Elasmostethus atricornis (Van D.). Que.: Hemmingford. Ont.: Ottawa.

Asopinae
Perillus bioculatus (Fabr.). Que.: Aylmer. Ont.: Guelph, London, Ottawa, Preston, Strathroy, Wingham. Alta.: Lethbridge. B.C.: Cranbrook.
Perillus bioculatus var. *clanda* (Say). Ont.: Guelph, Hastings Co., London, Ottawa, Preston, Wingham. Man.: Aweme, Cartwright, Dauphin. Alta.: Cowley, Red Deer. B.C.: Okanagan Ldg., Oliver, Vernon.
Perillus circumcinctus Stal. Que.: Lacolle. Ont.: Belleville, Hamilton, Hastings Co., Ottawa, Preston, Ventnor, Tramore. Man.: Aweme. Sask.: Buttress.
Perillus exaptus (Say). N.S.: Barrington Passage, Shelborne, Weymouth. N.B.: Boiestown. Que.: (no locality given). Ont.: Mer Bleue. Man.: Aweme, Dauphin, Melita. B.C.: Cowichan, Cranbrook, Crow's Nest Pass, Saanich, Terrace, Vernon.
Rhacognathus americanus Stal. Man.: Aweme, Winnipeg.
Apateticus cynicus (Say). P.E.Isl.: (no locality given). Que.: Aylmer, Covey Hill, Kingsmere. Ont.: Guelph, Hastings Co., Ottawa, Simcoe, St. Thomas.
Apateticus bracteatus (Fitch). Que.: Montreal. Ont.: Simcoe. Man.: Pipestone. Sask.: Saskatoon. Alta.: Lethbridge. B.C.: Goldstream, Vancouver Isl.
Apateticus crocatus Uhl. Man.: (no locality given). B.C.: Royal Oak, Saanich, Thormanby Isl., Victoria.
Podisus maculiventris (Say). N.S.: Halifax, Westport. N.B.: Fredericton. Que.: Covey Hill, Hemmingford, Hull, Lennoxville, Montreal. Ont.: Agincourt, Footes Bay, Hastings Co., Ottawa, Simcoe. Man.: Winnipeg. B.C.: Saanich, Sicamous, Vancouver, Victoria.
Podisus serieventris Uhl.. N.S.: Sydney. Que.: Ft. Coulonge, Kingsmere. Ont.: Footes Bay, Guelph, Monteagle, Ottawa. Man.: Onah. B.C.: Departure Bay, Vancouver.
Podisus modestus (Dallas). N.S.: Halifax, Weymouth. N.B.: St. Stephen. Que.: Aylmer, Chicoutimi, Ft. Coulonge, Lac des Mille Lacs, Montreal. Ont.: Belleville, Guelph, Hillier, Norway Pt. L. of Bays, Ottawa, Simcoe, Sudbury. Man.: Aweme, Glenboro. B.C.: Saanich, Terrace, Vernon, Victoria.
Podisus placidus Uhl. Que.: (no locality given). Ont.: Hastings Co., Ottawa. Man.: Aweme. B.C.: Chilliwack, Goldstream, Keremeos, Saanich.
Zicrona caerulea (Linn.). Ont.: Sudbury. Man.: Aweme, B.C.: Agassiz, Arrowhead, Duncan.

New Canadian species of Hemiptera described during 1928 in publications other than the "Canadian Entomologist".
Coreidae
* *Nisoscolopocerus apiculatus* Barber. Alta.: Medicine Hat, Apr. Journ. N.Y. Ent. Soc., XXXVI, 26, 1928.

Tingitidae

* *Acalypta nyctalis* Drake. Alta.: Bilby, June 1, 1924 (O. Bryant). Bull. Brook. Ent. Soc., XXIII, 6, 1928.

Nabidae

* *Nabis alternatus* var. *uniformis* Harris. B.C.: (no locality given). Ent. Amer. IX, 67, 1928.

Aphididae

* *Cepegillettea betulaefoliae* Granovsky. B.C.: Merrit (on *Betula occidentalis* Hook.).

Proc. Ent. Soc. Wash., XXX, 114, 1928.

DIPTERA

Chironomidae

* *Camptocladius pacificus* Saun. Nanaimo, B.C., (Saunders).

* *Camptocladius marinus* Saun. Departure Bay, Vancouver and Prince Rupert, B.C., (Saunders).

* *Camptocladius clavicornis* Saun. Departure Bay and Vancouver, B.C., Saunders). Ent. Soc. Am., Vol XXI, No. 4, 1928.

Mycetophilidae

* *Boletina crassicauda* Van Duz. Unalaska, Alaska, (G. D. Hanna).

* *Boletina atra* Van Duz. Skagway, (Kusch), Unalaska, Alaska, (E. C. Van Dyke).

* *Leia nigricornis* Van Duz. Unalaska, Alaska, (G. D. Hanna).

* *Exechia unicola* Van Duz. St. Paul Island, Alaska. (A. Christofeson).

* *Exechia borealis* Van Duz. Skagway, Alaska, (J. A. Kusche). Proc. Cal. Acad. Sci., Vol XVII, 1928.

HYMENOPTERA

Multillidae

* *Dasymutilla columbiana* Mickel. Nicola, B.C., (E. R. Buckell).

* *Dasymutilla abdita* Mickel. Osoyoos and Okanagan, B.C.

ORTHOPTERA

Locustinae

Melanoplus islandicus Blat. Dawson Road, Sandilands, Man., July 1928. (N. Criddle).

Tridactylinae

Tridactylus apicalis Say. Marchaud, Man., July, 1928. (E. and N. Criddle).

INDEX

Page

Acrobasis comptoniella Hlst. 15
Adalia bipunctata 19
Aedes aldrichi Dyar & Knab 35
Aedes campestris Dyar & Knab 35
Aedes cataphylla Dyar 35
Aedes hirsuteron Theobald 35
Aedes spp. 29
Aedes vexans Meigen 35
Agriotes mancus 21
Alder flea beetle 34
Allononyma vicarialis Zell. 12
Alsophila pometaria Harris 9, 12, 16, 19, 24
Anacampsis fragariella Busck 32
Anarsia lineatella Zell. 32
Ancylis comptana Froehl. 84
Aneoplex betulaecola Ashm. 77
Anisandrus dispar Fabr. 31
Anthonomus signatus Say 10
Ants 22, 25, 29
Anuraphis roseus Baker 8, 10, 19
Apant les thompsoni Lyle 39
Aphids 24, 27, 31
Aphis pomi DeG. 8, 10, 15, 17, 19, 31
Apple aphid 15, 17, 19
Apple curculio 17
Apple leafhopper 15, 19
Apple maggot 7, 10, 15, 17, 18, 93
Apple red bug 10, 19
Apple seed chalcid 10
Apple skeletonizer 9, 12
Apple sucker 8
Argiolimax agrostis L. 33
Argyroploce variegana Hbn. 11
Army cutworm 30
Armyworm 14
Ascogaster carpocapsae Viereck 7, 77
Aspidiotus perniciosus Comst. 18
Barathra configurata Walk. 23, 26, 27, 29, 32
Bark beetles 34
Batodes angustiorana Haworth 34
Bedbug 25, 29
Bedstraw hawk moth 36
Beet webworm 23, 27, 28
Bertha armyworm 23, 26, 29
Bertha cutworm 27, 32
Biting flies 31, 35
Black bodied cherry fruit fly 31
Black cherry aphid 10, 19, 32
Black flies 35
Black hooded tip moth 34
Blatella germanica L. 25
Brachyrhinus ovatus L. 32, 37
Brevicoryne brassicae L. 33
Bronze cutworm 14
Brown-tail moth 11
Budmoth 19
Buffalo treehopper 16
Bumble flower beetle 106
Byturus unicolor Say 32
Cabbage aphid 33
Cabbage flea beetle 33
Cabbage maggot 15, 18, 21, 24, 29, 33
Cacoecia argyrospila Walker 19

Page

Cacoecia cerasivorana Fitch 25
Cacoecia fumiferana Clem. 34
Cacoecia persicana Fitch 11
Cacoecia rosana Fitch 14
Caddice flies 37
Caliroa cerasi L. 31
Calligrapha californica Linell 36
Camel crickets 38
Camula pellucida Scudder 32
Canker worm 9, 19
Carabus nemoralis 37
Carpet beetle 22
Carpocapsa pomonella L. 11, 15, 17, 18, 31, 96
Carrot rust fly 7, 13, 15, 21
Cecidomyid 92
Celerio gallii intermedia Kirby 36
Cephus cinctus Nort. 23, 26, 27, 28, 30, 59
Ceramica picta Harr. 13
Ceresa bubalus Fab. 16
Chaoborus 37
Chermes spp. 16
Cherry case-bearer 17
Cherry fruit fly 19
Chionaspis pinifoliae Fitch 8, 24
Chorizagrotis auxiliaris Grt. 30
Chrysomelid 36
Cigar case bearer 11, 15, 19
Cimbex americana 13
Cimex lectularius L. 25, 29
Cirphis unipuncta Haw. 14
Cladius pectinicornis Four. 36
Click beetles 37
Clothes moth 22, 37
Cluster fly 22
Coast tent caterpillar 34
Codling moth 11, 15, 17, 18, 31, 65, 96, 104
Colorado potato beetle 13, 14, 23, 27, 33
Columbine borer 18, 22, 24
Conotrach lus nenuphar Hbst. 12, 15
Corn ear worm 13
Corythucha arcuata Say 24
Crambus ruricolellus Zell. 14
Crane flies 37
Cremastus minor Cush. 75, 76, 77
Cryptococcus fagi Baernsp. 8, 16
Cryptorhynchus lapathi L. 18
Currant aphid 25, 27
Currant fruit fly 25, 28, 32
Cutworms 13, 21, 23, 24, 26, 27, 32
Cyclamen mite 20, 21
Datana ministra Drury 16, 31
Dendroctonus brevicormis Lec. 34
Dendroctonus monticolae Hopk. 34
Dendroctonus pseudotsugae Hopk. 34
Depressaria heracliana DeG. 33
Dermacentor albipictus Pack. 35
Dermacentor venustus Banks 35
Dermestes lardarius 29
Dermestids 29
Diacrisia virginica Fabr. 36
Diamond-back moth 7
Dioctes obliteratus Cress. 75, 76, 77
Diphadnus appendiculatus Hartig 32
Disonycha davisi Shaef. 25

Page

Douglas fir beetle 34
Drug store beetle 36
Eastern tent caterpillar 12, 16, 17, 19
Ellopia fiscellaria Gn. 21
Ellopia somniaria Hulst 34
Elm sawfly 13
Empoasca mali LeB. 15
Entomoscelis adonidis Pallas 23, 27, 33
Ephestia kuhniella Zeller 38
Ephialtes aequalis Prov. 77
Epitrimerus piri Nalepa 19
Epitrix cucumeris Harr. 7, 14
Epiurus sp. 76, 77
Epochra canadensis Loew 25, 28, 32
Epilachna corrupta Muls 21, 107
Erannis tiliaria Harr. 24
Eriocampoides limacina Retz 16
Eriophyes pyri Pagnst 16
Eriophyids 19
Eriosoma lanigera Hausm 10, 31
Erycia myoidaea Desv 39
Erythroneura comes Say 20
Erythroneura tricincta Fitch 20
Estigmene acraea Dru 23
Eubadizon pleuralis Cress 77
Eulecanium corni 20
Eulia mariana Fern. 11
Eulimneria crassifemur Thom 39
Euphorbia inda Linn 106
Euproctis chrysorrhoea L. 11
European apple sucker 11
European beetle 37
European corn borer 14, 21, 38, 40, 43, 46, 49, 55
European dung beetle 15
European earwig 36, 38
European leaf-roller 14
European red mite 8, 11, 15, 19
Eupoa messoria Harr 23
Euxoa ochrogaster Gn 23, 26, 30
Euxoa tessellata Harr 23
Eye-spotted budmoth 9, 11, 15, 17, 31
Fall canker worm 12, 16, 24
Fall webworm 8, 16, 17, 33
Fannia canicularis Linn 57
Fannia scalaris Fab 57, 58
Felted beech coccus 8, 16
Feltiella venatoria Felt 92
Fir sawfly 24
Fir tussock moth 34
Fleas 38
Forest tent caterpillar 28, 29, 31, 34
Forficula auricularia L. 36, 38
Formica fusca 29
Four lined leaf bug 10
Four lined plant bug 14
Frankliniella tritici Fitch 30
Fruit tree leaf-roller 19
Galeruca externa Say 24
Galerucella carbo Lec 34
Galerucella decora Say 24
Garden slugs 33
Garden springtail 10
Gastrophilus haemorrhoidalis L. 36
Gastrophilus intestinalis DeGeer 36
Gastrophilus nasalis L. 36
Geotrupes stercorarius L. 15
German cockroach 25

Page

Glypta rufiscutellaris Cress. 75, 76, 77, 83, 85
Glypta varipes Cress 77
Gooseberry sawfly 32
Gortyna micacea Esp 8
Gracilaria syringella Fab 21
Grape berry moth 20
Grape leaf hopper 20
Grapholitha packardi Zell 31
Graptolitha antennata Walk 15
Grasshoppers 7, 21, 22, 26, 27, 30, 31, 32
Gray-banded leaf roller 11
Green apple aphis 8, 10, 31
Green apple bug 9, 12, 15
Green bud worm 11
Green fruit worm 12, 15
Ground beetle 37
Gryllus domesticus L. 22
Habrobracon tetralophae Vier 38
Haltica bimarginata Say 34
Haploptilia fletcherella Fern 11, 15, 19
Haploptilia laricella Hbn 8, 16
Haploptilia pruniella Clem 17
Harmolita tritici Fitch 7
Heliophobus procinta Grote 32
Heliothis obsoleta 13
Hemerocampa leucostigma S. & A. 9, 16, 17
Hemerocampa pseudotsugata McD. 34
Hemerophila pariana Cl. 12
Hemispherical scale 22
Hemlock looper 21
Hen louse 38
Hessian fly 7, 23, 28
Hop aphid 32
Hop flea beetle 32
Horn fly 35
Horse bot flies 36
House cricket 22
House flies 36, 57
Hyalopterus arundinis Fab 25
Hylemyia antiqua Meig 13, 15, 21, 24, 33
Hylemyia brassicae Bouche 15, 24
Hylemyia cilicrura Rond 14
Hyphantria cunea Drury 8, 16, 17, 33
Hypodtrma bovis DeGeer 35
Hypoderma lineata DeVilliers 35
Ichneumon 38
Illinoia pisi Kaltenbach 33
Illinoia solanifolii Ashm 7
Imported cabbage worm 13, 24, 33
Imported currant worm 26, 32
Isia isabella A. & S. 36
Itoplectis conquisitor Say 77
Itoplectis sp. 76
June beetle 18
Labrorychus prismaticus Nort 39
Lacewing 37
Larch case-bearer 8, 16
Larch saw-fly 16
Larkspur leaf miner 18
Laspeyresia molesta 19, 72, 77, 78, 80, 85
Laspeyresia nigricana Steph 7
Laspeyresia prunivora Walsh 31
Latrine fly 57
Leaf hoppers 12
Lecanium caprae L. 34
Lepidosaphes ulmi L. 12, 16, 18
Leptids (Biting) 35

Page

Leptinotarsa decemlineata Say........ 13, 14, 23, 27, 29, 33
Lesser apple worm 31
Lesser housefly 57
Lilac leaf-miner 21
Lime tree looper................................ 24
Lipeurus caponis Linn........................ 38
Lipeurus variabilis Nitzsch............. 38
Loxostege sticticalis L.................23, 27, 28
Ludius aeripennis 28
Lygidea mendax Reut.......................10, 19
Lygus communis Knight................... 9, 12
Lygus communis var. *novascotiensis* 15
Lygus pratensis...........................13, 14, 36
Lyperosia irritans L........................ 35
Macrocentrus ancylivora Rohwer.... 76, 80, 83, 84, 85
Macrocentrus delicatus Cress..........75, 84
Macrocentrus gifuensis Ashm.......... 39
Macrodactylus subspinosus Fab........ 20
Malacosoma americana Fab............. 12, 16, 17, 19
Malacosoma disstria 28
Malacosoma disstria erosa Stretch 31, 34
Malacosoma pluvialis Dyar................ 34
Maple leaf-cutter 18
Meal worm 38
Mealy plum aphid 25
Mediterranean flour moth 38
Melanoplus angustipennis................ 22
Melanoplus atlanis Riley.................. 7, 26
Melanoplus bivittatus Say................ 7
Melanoplus dawsoni 22
Melanoplus femur-rubrum 22
Meromyza americana Fitch.............23, 33
Meteorus sp 76, 77
Mexican bean beetle.........................21, 107
Microbracon brevicornis 39
Microbracon mellitor Say...........39, 76, 77
Microgaster 56
Microgaster tibialis Nees.................39, 55
Millipedes 21
Monophadnoides rubi Harr............... 20
Moose tick 35
Mosquitoes 25, 29, 31, 35, 37
Mountain pine beetle........................ 34
Musca domestica L........................... 36
Myzocallis alnifoliae Fitch............... 37
Myzus cerasi Fab..........................10, 19, 32
Myzus ribis L.................................... 25
Nematus erichsoni Hartig................. 16
Neodiprion abietis Harr.................... 24
Nephelodes emmedonia Cram.......... 14
Nepticula pomivorella Pack.............. 12
Nomius pygmaeus Dej....................... 37
Notolophus antiqua L........................ 28
Oak lace bug 24
Oat thrips 30
Oecanthus nigricornis Walk............. 20
Oestrus ovis L.................................... 36
Olive green cutworm......................... 32
Onion maggot...................13, 15, 21, 24, 33
Onion thrips 21
Oriental peach moth...19, 65, 66, 72, 80, 81
Oxyzaephilus surinamensis L........... 22
Oyster shell scale 12, 16, 18
Pachynematus ochreatus Harringt.. 25

Page

Paleacrita vernata Peck.................... 19
Pale western cutworm 26, 30
Papaipema cataphracta Grt............. 22
Papaipema purpurifascia G. & R..... 18, 22, 24
Paraclemensia acerifoliella Fitch.... 18
Paratetranychus pilosus C. & F....... 8, 11, 15, 19
Parsnip webworm 33
Pea aphid 33
Pea moth 7
Peach twig borer 32
Pear leaf blister mite 16
Pear psylla 19
Pear slug 16, 31
Pegomyia hyoscyami Panz................ 21
Pepper grass beetle 24
Peronea variana Fernald.................. 34
Phorbia brassicae Bouche......18, 21, 29, 33
Phorbia rubivora Coq......................... 32
Phorocera erecta Coq......................... 39
Phorodon humuli Schrank................. 32
Phyllocoptes fockeui Nalepa............. 19
Phyllophaga anxia Lec...................... 18
Phyllophaga spp 21, 22
Phyllotreta albionica Lec.................. 33
Phyllotreta vittata Fab...................... 21
Phytomyza sp 18
Phytophaga destructor Say..........7, 23, 28
Pieris occidentalis Reak.................... 24
Pieris rapae L...............................13, 24, 33
Pine needle scale............................... 8, 24
Plodia interpunctella Hbn................. 38
Plum curculio 12, 15
Plum flea beetle 25
Plutella maculipennis Curtis............ 7
Poecilocapsus lineatus Fab...............10, 14
Pollenia rudis Fab.............................. 22
Polychrosis viteana Clem.................. 20
Polystoechotes punctatus Fab.......... 37
Poplar borer 18
Porosagrotis orthogonia Morr..........26, 30
Potato aphid 7, 14
Potato beetle 29
Potato flea beetle............................... 7, 14
Potato stem borer.............................. 8
Prosimulium fulvum Coquillett........ 35
Prosimulium hirtipes Freis............... 35
Prosimulium novum D. & S.............. 35
Prosimulium pleurale Malloch.......... 35
Psila rosae Fab.........................7, 13, 15, 21
Psyllia mali Schmidb......................... 8, 11
Psyllia pyricola Forst........................ 19
Psylliodes punctulata Melsh............. 32
Pteronidea ribesii Scop.....................26, 32
Ptinus fur Linn.................................. 38
Pyrausta nubilalis Hbn....14, 21, 40, 49, 55
Raspberry *Byturus* 32
Raspberry cane borer......................... 32
Raspberry sawfly 20
Red-backed cutworm 30
Red-humped caterpillar 16
Red spider 20, 86
Red spider mite 31
Red turnip beetle 23, 27, 33
Rhagoletis cingulata Loew................ 19
Rhagoletis fausta O.S. 31
Rhagoletis pomonella Walsh............. 7, 10, 15, 17, 18, 93

moore

Page

Rhynchites bicolor Fab.... 24
Roadside grasshopper 32
Root maggot 14
Rose chafer 20
Rose curculio 24
Rose sawfly 36
Rosy aphis 8
Rosy apple aphid 10
Round-headed apple tree borer.... 17
Rusty tussock moth.... 28
Saissetia hemisphaerica Targ.... 22
Salt-marsh caterpillar 23
San Jose scale 18
Saperda calcarata Say.... 18
Saperda candida Fab.... 17
Satin moth 33, 37
Sawfly 35
Saw-toothed grain beetle.... 22
Schizura concinna S. & A.... 16
Scolytus rugulosus Ratz.... 12
Seedcorn maggot 14
Seius sp 92
Serpentine leaf miner.... 12
Sheep nose maggot.... 36
Shot hole borer....12, 31
Silverfish 22
Simaethis pariana Clerck.... 9, 12
Simulium venustum Say.... 35
Simulium virgatum Coq.... 35
Simulium vittatum Zett.... 35
Sitodrepa panicea L.... 36
Slugs 13, 15, 16, 21
Sminthurus hortensis Fitch.... 10
Soft scale 34
Spiders 38
Spilonota ocellana D. & S....9, 11, 15, 17, 19, 31
Spinach leaf-miner 21
Spring tails 13
Spruce budworm 34
Spruce gall aphids 16
Spruce sawfly 25
Stalk borer 22
Stethorus punctum Lec.... 92
Stilpnotia salicis L....33, 37
Strawberry root weevil 32, 37
Strawberry weevil 10
Striped cutworm 23
Stripped tree cricket.... 20
Sunflower beetle 23
Symphoromyia atripes Bigot.... 35
Symphoromyia plangans Will.... 35
Syntomaspis druparum Boh.... 10
Tabanus osburni Hine.... 35
Tabanus punctifer O. S.... 35
Tabanus sequax Will.... 35

Page

Tachinid sp 75
Tachypterellus quadrigibbus Say.... 17
Tarnished plant bug....9, 13, 14, 36
Tarsonemus pallidus Banks.... 20
Tenebrio molitor Linn.... 38
Termites 38
Termopsis angusticollis Hagen.... 38
Tetranychus bimaculatus Harvey.... 31
Tetranychus flavus Ewing.... 11
Tetranychus telarius L....20, 86
Thecodiplosis mosellana Gehin.... 33
Thorn skeletonizer 12
Thrips tabaci Lind.... 21
Ticks 31, 35
Tineola biselliella Hummel.... 37
Tortricid leaf rollers.... 28
Tortricid moth 34
Trachykele blondeli Mans.... 34
Trialeurodes vaporariorum Westw. 22
Triaspis sp 76, 77
Trichogramma minutum Riley.... 38, 40, 72, 73, 74, 77, 83, 84
Triphleps 92
Troctes divinatorius Miller.... 38
Tromera sp 76, 77
Turnip flea beetle 21
Tussock moth 12
Typhlocyba pomaria McA.... 19
Ugly-nest caterpillar 25
Warble flies 35
Western cedar borer 34
Western cherry fruit worm.... 31
Western hemlock looper 34
Western pine beetle 34
Western strawberry leaf roller.... 32
Western white butterfly.... 24
Western willow leaf beetle.... 24
Wheat joint worm.... 7
Wheat midge 33
Wheat stem maggot....23, 33
Wheat stem sawfly....23, 26, 27, 28, 30, 59, 60
White fly 22, 25
White grubs 18, 21, 22
White marked spider beetle.... 38
White marked tussock moth....9, 16, 17
White triangle leaf roller.... 11
Willow borer 18
Willow leaf beetle.... 34
Wireworms....7, 13, 21, 22, 27, 28, 30, 33
Wood tick 35
Woolly apple aphid 10, 31
Woolly bear caterpillar.... 36
Yellow-necked caterpillar....16, 31
Zebra caterpillar 13
Zenillia caesar Ald....38, 39
Zygogramma exclamationis Fab.... 23

THE END